

# RAPTOR RESEARCH



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Devoted to the Golden  
Eagle

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## RAPTOR RESEARCH

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## HUMAN IMPACTS ON GOLDEN EAGLES: A POSITIVE OUTLOOK FOR THE 1980s AND 1990s

by

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Until recent decades the Golden Eagle (*Aquila chrysaetos*) was literally shot on sight by predator control agents of the federal government, animal damage control personnel from state and local governments, caretakers of private hunting clubs, and even the public at large. The persecution complex of certain segments of American society even extended to our national emblem, the Bald Eagle (*Haliaeetus leucocephalus*.)

Eagle electrocutions, shootings, poisonings, and other such killings were considered beneficial by many—long after the Bald Eagle Protection Act was passed in 1940. Ironically, bounties were paid in Alaska for years after the enactment of protective legislation. And for some time after the Bald Eagle Protection Act was amended in 1962 to afford Golden Eagles similar protection, it was equally apparent that persecution of that species might continue indefinitely. Evidence abounds in the literature for considerable shooting and poisoning of Golden Eagles through the early 1970s.

But these direct mortality factors are not the only problems eagles have suffered in this century. There has also been during the same period of extensive persecution a great disarrangement of Bald and Golden Eagle habitats. The list of indirect detrimental factors runs from agricultural to urban development and includes the effects of harassment by pilots of small aircraft, sonic booms and low overflights by military planes, construction of dams and reservoirs, land conversions and other range management practices, casual human disturbance, timber management, mining and oil and gas development, power line construction and operation, recreation of many types, contamination by heavy metals and pesticides, and the building and use of roads and railroads. The cumulative effects of these numerous impacts seen staggering, yet, in spite of them, the Golden Eagle remains a common bird in the intermountain western United States and parts of Mexico and Canada.

The decade of the 1970s was truly a transitional period in American conservation. Public attitudes toward eagles and other raptors changed, as did the understanding of possible long-term effects of man's extensive use of key components of natural ecosystems. Positive changes began in the Fifties and Sixties, culminated in the Seventies, and many of them are still with us in the Eighties. These changes include the following:

1. Over 120 Indian tribes have essentially stopped killing eagles specifically for use in ceremonial headdresses, each of which took feathers from up to five eagles. They now obtain eagle feathers from carcasses collected by the U.S. Fish and Wildlife Service.

2. Shooting and trapping of eagles by Federal and state predator control agents has stopped. No permits to dispose of eagles suspected of preying on sheep have been given to ranchers for nearly a decade. Of particular note are the large fines and other penalties for shooting eagles from aircraft and the possible loss of Federal grazing rights by ranchers who violate eagle protection laws and regulations.

3. Use of rodent and coyote control poisons has been significantly curtailed on feder-

ally owned lands, and violations are actively investigated by U.S. Fish and Wildlife Service law enforcement agents. The abusive use of thallium sulfate in Wyoming in 1971 that killed numerous Bald and Golden Eagles indeed sparked a new era.

4. The public at large has been placed under closer scrutiny in cases of eagle shootings owing to the reward program of the National Wildlife Federation and the provision awarding half of all fines under the Bald Eagle Protection Act to an informant who provides evidence leading to a conviction.

5. The problem of eagles being electrocuted by power lines has been significantly reduced during the past decade through cooperative efforts of governmental agencies, conservation organizations, and the electric industry. This cooperation is now being extended into positive eagle habitat management programs by power companies.

6. Of great significance to the Bald Eagle, and to a lesser extent the Golden Eagle, use of DDT was banned in the early 1970s, and bans or severe restrictions have been placed on use of other persistent organochlorine pesticides. Considerable evidence of recovery in Osprey, Bald Eagle, Brown Pelican, and some Peregrine Falcon populations now exists.

7. To an unprecedented degree, changes in land use in eagle habitats are now routinely analyzed for their impacts on eagle populations, especially on Federal lands. Habitat management plans, nest territory plans, environmental assessments, and both short-term and long-term land-use plans of governmental agencies—and even plans for land consumptive private industrial projects—consider the well being of Bald and Golden Eagles.

8. Several refuges and sanctuaries were established during the 1970s which emphasize eagle protection. Examples include Idaho's Snake River Birds of Prey Natural Area (and proposed National Conservation Area), the Skagit River Bald Eagle Natural Area in Washington State, the Seymour Eagle Management Area in Alaska, and the Eagle Rock Audubon Sanctuary in Colorado.

9. Finally, the decade of the Seventies saw tremendous strides in research on various eagle management techniques including captive breeding, introduction of eagles to the wild, artificial feeding, nest relocation, and provision of artificial nesting structures. While these techniques may be more important to Bald Eagles in the early 1980s, existing management techniques have been proven appropriate for the Golden Eagle whenever the need arises.

While all of these relatively recent improvements in the relationships between man and eagles do not allow total optimism for the future, it is important to recognize that at the same time as American Indians were using eagle feathers heavily, persecution by control agents and ranchers was the worst, poisoning was at its peak, shooting by the general public was high, electrocution of eagles by power lines was far more commonplace, use of persistent pesticides was rampant, land use was proceeding without regard to eagle habitat protection, very few refuges or sanctuaries existed, and there was no confidence in our knowledge of eagle management techniques—when all of these things prevailed, there were still relatively high numbers of Golden Eagles throughout the West. One can speculate that Golden Eagle populations were slowly declining during that time, but it is impossible to produce conclusive evidence.

It is just as easy to speculate today that Golden Eagle numbers are slowly rising. What is even more clear, however, is that regional Golden Eagle populations are still regulated far more by natural fluctuations in jackrabbit numbers than they are by man's



activities. Research conducted by the Snake River Birds of Prey Study Group in Idaho and by others clearly shows that many adult Golden Eagles do not breed when the prey base is low. Data also indicate that the number of young produced is directly related to prey availability. Thus, the relatively slow reproductive rate and long maturation period of Golden Eagles does not allow them to follow year-to-year fluctuations in prey numbers as closely as smaller, earlier maturing raptors with higher reproductive potentials. However, the longevity of mature Golden Eagles carries the species through years when they cannot breed, leaving the major burden of mortality on younger age classes.

Thus, whether Golden Eagle populations are slowly declining or slowly increasing in 1982 may not be relevant to long-term survival of the species. We must not become preoccupied with counting eagles—either live ones or dead ones. Rather, our valuable attention must be focused wherever traditional Golden Eagle nesting areas have been or soon will be taken over by man's pursuit of land ownership, land-based recreation, and land consumptive businesses. We must focus on improving what we have spoiled and on minimizing the effects of what we have planned. What will be required is more change. The behavioral and distributional traditions of certain pairs of Golden Eagles, which use land man wishes to "disarrange," must be modified. And there must be a corresponding change in the perception of and attitude toward nature by much of the human population, particularly the decisionmakers in our society.

In fact, the latter change is occurring. Witness the nine points discussed above. What is too often overlooked, however, is that the behavior of raptors is changing: "birds of prey are exploiting the potential of living in concert with men. Given half a chance, they will even breed in spite of us...Birds of prey can live close to man: near busy highways, in areas used heavily for recreational purposes, and within stone's throw of buildings, windmills, and other man-made structures. Some even nest on objects like utility poles, windmills, abandoned buildings, and steel towers." (Olendorff, R. R. 1975. *Golden Eagle Country*. Alfred A. Knopf, New York. p. xv.)

To the staunch idealist this may not be good news; wild things must exist in pristine settings or not at all. To the perceptive realist, however, the ability of individuals of a species to adapt to an inevitably changing world is an exploitable trait. This trait may well ensure the survival of the species, not only in areas which remain wild and natural, but also in nearby disturbed areas which can possibly be managed to produce as many or more Golden Eagles as undisturbed areas.

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One of the most promising exploitable traits of certain raptors which allows a positive outlook is this capacity for nesting on man-made nest substrates. For every traditional nest site of Golden Eagles taken over by human activities and other land-uses, there is a void created which might be filled with birds through management. In many cases only the nest site is rendered useless. Foraging areas, which characteristically are more flexible and not so site specific, are commonly left intact, but poorly used, being too distant from an adequate nest site. Such local gaps in raptor populations also occur naturally, particularly in the vast monotypical sagebrush and grassland habitats of mid-western and western North America.

In light of this, it is not surprising that raptors commonly build nests on power line transmission towers erected in these voids. Nor is it surprising that industry is supporting



considerable research to exploit this trait—first as a raptor habitat management technique and second as possible mitigation for the adverse impacts of development on raptors.

One such research project is being conducted by Pacific Power and Light Company (PPL) along a 525-mile transmission line running between Midpoint (near Twin Falls), Idaho, and Malin, Oregon (Fig. 1). Thirty-seven steel nesting platforms were included as part of the initial design and construction of this line. The platforms were patterned after the original wooden and fiberglass versions used in the pilot programs conducted by the Idaho Power Company, Utah Power and Light Company, and Bonneville Power Administration in several western and northwestern states.

The PPL structures are made of 1/4-inch galvanized steel and are expected to last the life of the line. They were mounted below the conductors to help prevent possible flashovers caused by bird excrement and also to provide easier access by researchers. Collection of data from these platforms is just beginning and will require long-term monitoring, but, even at this early date, observations have yielded information which may be useful in similar programs now under consideration.

Exactly 20 Golden Eagle eyries are known to have been abandoned during the past 30 years outside of the Snake River Canyon but within 20 miles of the Idaho stretch of the new PPL line. There certainly have been more abandonments where historical occupancy was never documented and where very old records could not be verified by nest remains or other evidence during site visits made in 1982. But in only one of 20 verifiable cases is at least one of the adult birds known to have been killed; most of the remainder have apparently been forced away by human activity.

Regardless of the precise number of abandoned Golden Eagle eyries, human activities have created an unusual need for nesting sites for nearly 20 pairs of adult eagles which may still have decades to live. One scenario is that some of these displaced birds have taken up residence between the Snake River Canyon and the mountains to the north. In this area an adequate prey base exists, but nesting sites are either not available, marginally useable, or already in use.

In 1980 and 1981 PPL placed 12 of the 37 steel artificial platforms in Idaho. In 1981 and 1982, four of these Idaho platforms were occupied by raptors: 2 by Golden Eagles, 1 by Ferruginous Hawks (*Buteo regalis*), and 1 by Red-tailed Hawks (*Buteo jamaicensis*). This level of occupancy after only one or two years is noteworthy, but the speed with which some pairs of eagles adopted the structures is even more remarkable. This was particularly noticeable in a case along the new PPL line at Little Canyon Creek where the platform seemingly provided a better nest site than the traditional (marginally useable?) cliff nest site.

The PPL line runs 400 yards south of the well established nest site on a south-facing cliff in the bottom of the canyon. Three stick nests are maintained by the adults. One has a little shade into which young birds can escape from the searing summer heat. The other two nests have no shade, and in an average year the young often succumb to heat prostration, a well documented mortality factor of young Golden Eagles. The heat problem at Little Canyon Creek is accentuated by the cliff being at the bottom of a canyon with little air movement and by the black basalt rock which absorbs the sun's heat.

The PPL line was finished during the fall of 1981 after one young was raised in the shaded Little Canyon Creek cliff site. The adults had an opportunity to perch on and inspect the platform during early winter courtship. Apparently, a rapid change from the

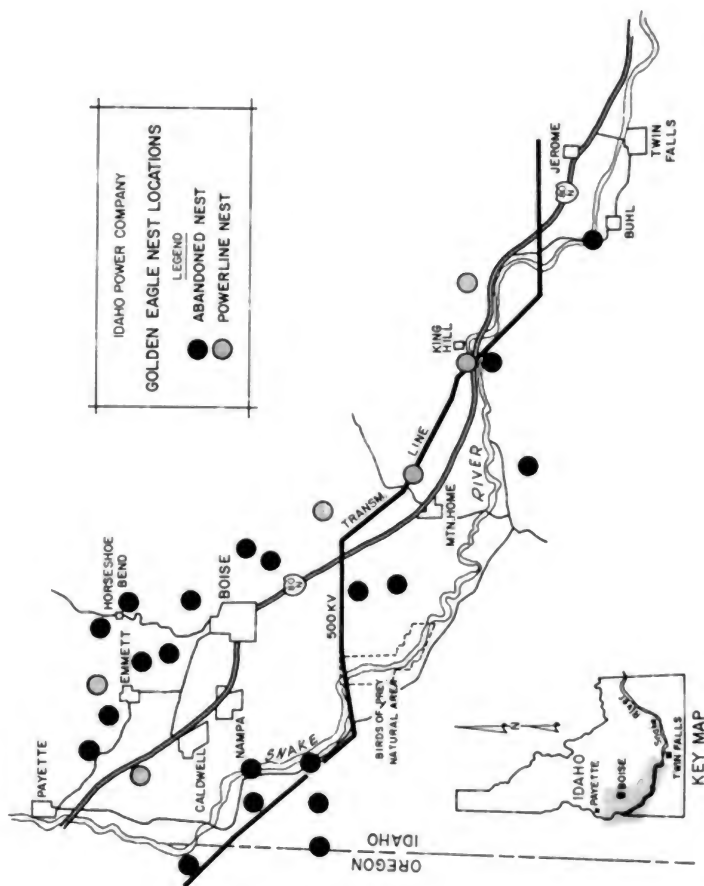


Fig. 1. Golden Eagle nest locations along the PPL transmission line in Idaho and Oregon.

old site was made, because on May 27, 1982, two young in the platform nest already had pin feathers, while the cliff nests were unoccupied.

Choice of nest sites by birds is a complex behavioral process that man knows little about. The importance of "site selection tours" was recognized years ago (D. Nethersole-Thompson and C. Nethersole-Thompson, *British Birds* 37: 70-74, 88-94, 108-113, 1944), but the factors which are evaluated by birds when they brood empty nests during these tours are unknown.

We can at least speculate about these factors in the case of the eagles nesting on the platform near Little Canyon Creek. Commonly, the wind direction of a storm will dictate where Golden Eagles perch on a cliff or power line. They carefully position themselves in calm areas and eddies which differ for each direction of the wind. This ability to respond to wind direction also protects them from wind driven rain or snow.

Likewise with nesting on cliffs or power lines. Three "shelter" factors are critical: 1) the availability of shade and wind protection for young eagles, 2) the existence of cooling air currents passing by the open towers, and 3) the anchoring of nests to prevent blowdowns in strong winds. The corners of power line towers are angular and much wider than they appear from the ground. It is relatively easy for eagles to find microclimates on large towers very similar to protected areas on a cliff. Towers also provide shade from numerous angles as the summer sun moves across the sky. The peaked shelter provided by the platform design also may emphasize shade and wind protection for the birds during "nest site selection tours".

Another important factor which may have drawn this pair of eagles away from a seemingly marginal nest site onto an artificial platform is visibility. The impacts of casual human disturbance on raptors can be minimized if the birds are not surprised at their nests. Tremendous security is provided when Golden Eagles have time to communicate danger to their eaglets when it is still a half mile or more away and then time for the adults to flee to a watchful position high overhead. It is very difficult to see young raptors on these platforms from the ground below, particularly when they lay motionless. The adults may be able to sense this circumstance through instinct, even during the early "site selection tours."

The origins of the other pair of Golden Eagles on the new PPL line and several other pairs nesting on wooden platforms or directly on towers along the adjacent Idaho Power Company line are unknown. This lends support to the idea that they are displaced pairs from some of the 20 or more abandoned sites, but closer study and more platform use is necessary to prove the point conclusively. Such a study is being developed cooperatively by Pacific Power and Light Company and the U.S. Bureau of Land Management.

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The use of man-made nest substrates by raptors has been recognized as an indicator of management potential for some time (Olendorff, R. R. and J. W. Stoddart, Jr., *Raptor Research Report* No. 2:47-88, 1974). Utility poles and electric transmission towers are by far the most common types of artificial nest substrates used by raptors.

In my view the quickness with which some pairs adopt artificial structures, such as platforms on transmission towers, illustrates an "intelligence" factor, rather than a long-term behavioral modification. (The latter terminology might best be reserved for cases

where young raptors raised on man-made substrates return as adults to nest on similar substrates, e.g., power line towers). My long association with Golden Eagles makes it difficult for me not to attribute short-term behavioral choices to experience, "intelligence," and communication between paired adults and between adults and their nestlings.

Whether the wind, sun, and visibility factors—or other undetectable habitat characteristics—are recalled by the eagles through conditioning, instinct, or "intelligence" is a fine point of debate. More important is the recognition that it does happen. It is part of their behavioral repertoire and should be incorporated into eagle habitat management plans—as well as development project designs, which involve lands where the absence or low quality of nest sites limit eagle population numbers. In this way complete territories can be created for raptors displaced by human activities, and we can add a tenth reason to our list of accomplishments which allow for a more positive outlook for eagles in the 1980s and 1990s.

## **WHAT IS THE FUNCTION OF UNDULATING FLIGHT DISPLAY IN GOLDEN EAGLES?**

by

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### ***Abstract***

Undulating flight displays of the Golden Eagle (*Aquila chrysaetos*) have been interpreted as serving mostly pair bond maintenance or courtship functions. Fifteen displays performed by several individually recognizable pairs of Golden Eagles were witnessed in northern Colorado over a 6 year period. Most displays seemed to be stimulated by and directed at intruders known to be within the home range, suggesting an aggressive and territorial function of the display. Gender specific defense of the territory was also indicated. Copulation was observed during all seasons, but was never associated with undulating display. Evidence is presented suggesting displays of eagles in winter are an expression of seasonal territoriality rather than pair bond maintenance. The function of undulating flight display may be determined by observing the responses of eagles displayed to, or by distinguishing subtle differences between displays performed for courtship pair bond maintenance and those for aggressive territorial reasons.

### ***Introduction***

Undulating flight displays (Brown and Amadon 1968: 95; Fig. 1) of Golden Eagles have been witnessed and described many times (Bent 1937, Jollie 1943, Gordon 1955, Snow 1973, Brown 1977, Ellis 1979), and in nearly all instances the behavior was considered to be mainly sexual. Arnold (1954) stated that such aerial displays were included in

courtship activities of Golden Eagles, and Brown and Amadon (1968) considered undulating flight to be "purely nuptial or sexual in function". Bent (1937) regarded the display as often "merely joyful exercise" but primarily a "compulsion" to maintain the pair bond, and Brown (1977) felt that undulating display is one stage in a progression of specific epigamic or nuptial displays. Because the majority of Golden Eagle studies have concentrated on behavior only during the breeding season, the relationship of undulating flight displays to sexual function may have been overemphasized.

The context of undulating flight displays in some accounts suggest aggressive or territorial function to the behavior. Kochert (1972) watched an adult eagle undulate then chase an immature eagle from the territory; but no mention was made of a relationship between the display and aggression. Ellis (1979) noted that undulating flight was most often performed by territorial adults during the breeding season, hinting that the behavior may also function in territory defense. Brown (1977) stated that eagles are stimulated to undulate in the presence of intruders, also suggesting an alternative or additional function of the display, but he concluded that aerial undulations of eagles are "most likely to be in nuptial display than attacking or hunting". Brown (1977) also felt that displays of raptors in winter served primarily a pair bond maintenance function, but displays during the nonbreeding season may be more indicative of seasonal territoriality. Migrant Rough-legged Hawks (*Buteo lagopus*), Steppe Eagles (*Aquila rapax*) and Bonellis' Eagles (*Hieraaetus fasciatus*) have been known to display on their wintering grounds (Brown 1977), but few studies of these species have been conducted during the nonbreeding season and none with identifiable individuals. It is possible that had the habits and spacing of the displaying birds been known, an intruder may have been recognized in the vicinity. Little Eagles (*Hieraaetus morphnoides*) and Wedge-tailed Eagles (*Aquila audax*) also display outside of the breeding season and often in response to an in-

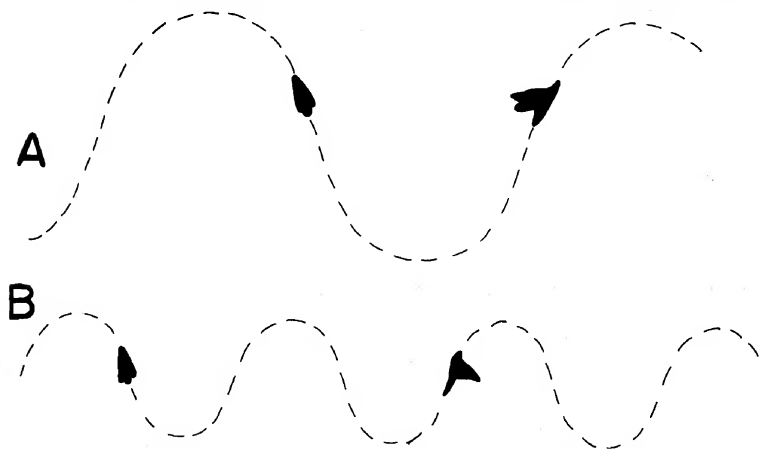


Figure 1. Relative amplitudes and frequencies of undulating flight displays of Golden Eagles at (A) high altitude (B) low altitude observed in northern Colorado, 1972-1979.

truder (S. Debus, pers. comm., Univ. of New England, NSW, Australia, 1981). I propose that the undulating flight behavior of Golden Eagles is primarily a territorial and threat display stimulated by the presence of intruders, while less frequently stimulated by reproductive drives for courtship or pair bond maintenance.

### Methods

Observations were made in northern Colorado between November 1972 and March 1979 in connection with studies of resident adult and fledgling Golden Eagles, as part of biologistwarden duties on the National Audubon Society's Eagle Rock Sanctuary and during summer and winter raptor banding operations. During 6 years of field work, I became familiar with habits and ranges of many Golden Eagle pairs. Individuals were often identifiable by plumage characteristics, behavior with a mate, habitual movements through their range, use of "preferred" perches and association with nest sites. In addition, I witnessed displays of 2 of 4 resident radio-tagged adults. Conspecific intruders were often identifiable because of a lack of distinctive markers and general non-predictable use of the range, perches and roosts, and unfamiliar habits. Displays were often performed at extreme distances and quantification of certain components was therefore subjective; relative relationships, however, were obvious.

### Results and Discussion

Fifteen undulating flights were observed (Table 1). The altitude, amplitude, and frequency of oscillations remained constant within each undulating display, but varied among displays. Low altitude displays (<100 m) seemed more intense, with undulations more frequent and with smaller amplitudes, than high altitude displays (Fig. 1). The intensity of a display seemed greater the closer an intruder was to a nest site or hunting area used by the resident pair. All displays terminated at approximately the same altitude they began. Seventy-three percent of observed displays occurred while an intruder was known to be within the home range of resident pairs and almost all were performed at low altitude. Ninety percent were performed while both mates were present. Displays in which just one member took part comprised 80%. In these instances, 66% were performed during winter months. In most cases, intruding eagles left the home range minutes after the initiation of the display, and the resident pair ceased undulations al-

Table 1. Circumstances of undulating displays by Golden Eagles observed in northern Colorado, 1972-1979.

| Adult Pair     | Displays Seen | Number           |        |      | Mate Present | Intruder Seen | Species Displayed Against | Month of Occurrence (#) |
|----------------|---------------|------------------|--------|------|--------------|---------------|---------------------------|-------------------------|
|                |               | Members Involved |        |      |              |               |                           |                         |
|                |               | Male             | Female | Both |              |               |                           |                         |
| Finger Eyrie   | 4             | 2                | 1      | 1    | 4            | 4             | Golden Eagle              | March (2)               |
| IBP            | 4             | 1                | 1      | 2    | 3            | 3             | Ferruginous Hawk          | January (1)             |
|                |               |                  |        |      |              |               | Man                       | May (1)                 |
|                |               |                  |        |      |              |               | Golden Eagle              | January (2)             |
|                |               |                  |        |      |              |               | Ferruginous Hawk          | April (1)               |
| Owl Canyon     | 2             | 2                |        |      |              |               |                           | December (1)            |
|                |               |                  |        |      | 1            | 1             | Golden Eagle              | November (1)            |
|                |               |                  |        |      |              |               |                           | October (1)             |
| Park Creek     | 1             | 1                |        |      |              |               |                           | February (1)            |
| Great Wall     | 1             |                  | 1      |      |              | 1             | Ferruginous Hawk          | June (1)                |
| Pawnee Breaks  | 2             | 1                | 1      |      | 1            | 2             | Golden Eagle              | January (1)             |
|                |               |                  |        |      |              |               |                           | March (1)               |
| Iron Clad Rock | 1             | 1                |        |      | 1            | 1             | Golden Eagle              | June (1)                |

most immediately thereafter. This suggests that the presence of an intruder rather than sexual drive stimulates most undulating flight displays.

An undulation display, involving a juvenile Golden Eagle displaying towards an intruding adult eagle, was observed in April 1974. A banded eagle, produced by a resident pair the previous season, was observed undulating and diving at an adult standing on the ground while his parents perched on fence posts nearby. After 12 min of displays interspersed with aggressive stoops, the intruding eagle took off and unhurriedly flew away. The juvenile ceased displaying less than a minute later. The age and aggressive stoops of this juvenile suggest that the undulation display was not an attempt at courtship or pair bonding, but an attempt to drive an intruder out of a territory.

The most convincing evidence that intruders induce the undulation display involved an aggressive interaction between 2 resident adults and 2 intruding adults. On 23 December 1974 at about 1515, the radio-tagged IBP female eagle (Table 1) was circling approximately 20 m over a large, isolated saltbush (*Atriplex* spp.) and sage (*Artemisia* spp.) flat surrounded by short-grass prairie. Abundant shrubs on the flat provided excellent cover and food for many jackrabbit (*Lepus* spp.) and cottontail (*Sylvilagus* spp.). The flat was 2 km southwest of the IBP eagles' nest site, and was used for hunting by those eagles during winter months more often than any other area in the home range. Seconds after being joined by her mate, the circling eagles dove in tandem toward an adult eagle, judged by size to be a female, perched on the ground. The intruder leaped and presented talons to the attacking pair but no contact was made. After 2 more passes the resident birds perched on separate knolls bordering the flat. While the residents perched, a small adult eagle (presumably a male and the intruder's mate) appeared. Two more attacks by the resident pair followed, interspersed with perching. Preceding the third attack, both resident eagles performed an intense undulating display, consisting of a series of low, quickly executed undulations with peaks approximately 15 m off the ground. In an ensuing period of 38 min all 4 adults performed low altitude undulating displays (Fig. 1, B) at least once, the resident pair many times. The intruding male was knocked off the vane of a windmill by the resident male; the resident female landed next to the intruding female, and excreted in her direction; and all eagles dived at their perched opponents at least once. The encounter culminated in a mid-air collision of the resident female who, while attacking from the air, was met by the intruding female leaping from the ground. The eagles then grappled with each other on the ground for over 2 hr. As darkness set in, the fight continued, and terminated only when I approached within 2 m of the combatants. Evidently, this was a battle for control of a prime hunting territory, and both pairs displayed as each claimed title to the area. Since neither relented, an intense fight ensued and, had it not been for my intervention, could have resulted in death for at least one of the eagles.

Defense of the territory may be gender specific. In the above conflict, the resident IBP female directed the majority of her undulations and aggressive dives towards the intruding female while the resident male directed most of his displays and dives toward the intruding male after he appeared. In addition, resident males were observed to perform 66% of all displays in which only one member of the pair participated, most of which occurred between March and May. During this season the females are occupied with incubation/brooding activities and were often fed by males. It is, therefore, the male who is most responsible for territory defense and food acquisition and likely to drift into other occupied territories stimulating defensive displays of adjacent pairs. M.



Lockhart (pers. comm.) observed a resident male chase an intruding male from his territory after the resident female had been soaring casually with the intruder. Olendorff (1973) watched Golden Eagles exchange incubation duties after which the female gained altitude and began undulating. Possibly the male watched an intruding female enter the territory and relieved his mate so she could defend the territory. Ellis (1979) watched an adult female leave her eyrie and grapple with an immature eagle in mid-air, after which the immature "left the area rapidly". Prior to the contact, the adult male had been soaring near the immature. Ellis (pers. comm.) felt that the immature was also a female. Gender specific territorial defense would facilitate rapid replacement of lost mates.

On 3 occasions, resident adult Golden Eagles undulated and subsequently chased Ferruginous Hawks (*Buteo regalis*). These encounters lasted only seconds and undulations were considerably less intense than those directed at other eagles. Potential competition for food may have been the cause for aggressive behavior as the diet of Ferruginous Hawks is similar to that of resident Golden Eagles in northcentral Colorado (Olendorff 1973).

In May 1978 and March 1979 the Finger Eyrie male performed a series of undulations apparently directed towards a human intruder. In both instances, as I approached on foot to within 150 m of the incubating female, the male left his most commonly used perch 200 m to the east of the nest. He then undulated vigorously less than 20 m from the ground and about 100 m in front of me. I immediately withdrew and he returned to his perch.

I have visited the Finger Eyrie at least once a year since 1972 and have driven within 150 m of the resident pair many times, all with the least possible disturbance. Perhaps, since the Bald Eagle (*Haliaeetus leucocephalus*) is known to recognize individual humans and vehicles (Edwards 1969), Golden Eagles do also and the Finger Eyrie male has come to recognize me as no more than an unwanted intruder.

Eagles may maintain pair bonds by behavior patterns other than display. Radio-tagged adult Bald Eagles were observed to copulate on the wintering ground (Harmata in prep.) but were not seen to display to mates over a 3 month period of intensive winter tracking, during migration nor prior to nest building and egg laying. Aerial cartwheeling displays believed to function in courtship and pair bond maintenance (Retfalvi 1965; Hancock 1970; Brown 1977), involving both adult and immature Bald Eagles, occurred during winter months but were always observed during aggressive aerial chases resulting from conflicts over food or infringement on individual space. Almost half (46%) of all undulating flight displays of Golden Eagles discussed here occurred during winter but were never observed in association with copulation. Copulation was observed several times and during all seasons but was pre-empted and/or followed by one or more of these activities: mutual soaring, rolling and foot touching (Brown 1977), cliff racing (as described for the Prairie Falcon, *Falco mexicanus*, Olendorff 1973) and long periods of perching close together. Bald and Golden Eagles in winter therefore appear to maintain their pair bond sexually and by close association rather than display, and the same may be true for several other species of large raptors.

*Undulating Flight Display: Sexual or Territorial in Function?* Territorial signals in vertebrates may be closely related with mating behavior (Wallace 1979), and displays of many avian species involve both sexual and aggressive tendencies (Hinde 1970). Un-

dulating flight displays of Golden Eagles have been previously reported as primarily being associated with sexual function while evidence presented here also indicates a relationship to aggression and territoriality. Two strategies for resolving these conflicting tendencies have been identified in other birds and may help in defining the function of undulating display of Golden Eagles:

(1) Courtship in birds, especially Tetraonids, is often initiated by aggressive behavior, as males display to females in the same way they would to competing males (MacDonald 1968, Hjorth 1970). Subsequent behavior of the male depends on stimuli the female presents and his internal state (Hinde 1970). Undulating flight displays of Golden Eagles may therefore be initially stimulated by aggression but the response of the bird being displayed to may dictate the ultimate function, i.e. courtship and pair bond maintenance from responses of a mate or aggression and territorial defense from responses of an intruder. Viewed in this context, the same display could serve two functions.

(2) In some species, displays that function in both agonistic and sexual situations may actually be separated by subtle differences in components, depending on the specific context in which they occur. The sexual function of pivoting displays in Goldfinches (*Carduelis spp.*) is often distinguished by a call seldom heard during agonistic encounters involving the same display (Hinde 1970). Courtship "follow flights" of the Turkey Vulture (*Cathartes aura*) differ from aggressive pursuits of intruders in that trailing birds do not drop their feet during stoops when courting a mate (Davis 1979). A difference in characteristics between high and low altitude undulating displays of Golden Eagles was noted (Fig. 1). Intruders were not known to be within the home range during most high altitude, low intensity displays. These displays could serve primarily a courtship/pair bond maintenance function while more intense low altitude undulating flights function as mostly territorial/aggressive displays. However, it is possible that high altitude displays may be totally aggressive responses to actual or imminent violations of territory at the fringes, performed at altitudes most obvious to intruders at a distance. In any event, a display elicited in these contexts would serve a specific, singular function.

Newton (1979) felt that displays given long after pair formation in the breeding season, were most likely given in response to an intruder. In animals that pair for extended lengths of time, aggression between mates recedes as they become more acquainted (Manning 1967). Golden Eagles are a monogamous, long-lived species and it is therefore likely that aggression between mates of well established pairs is minimal. With a major component of courtship display absent, subsequent displays will most likely be in response to intruders and function in territorial defense.

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# FOOD HABITS OF NESTING GOLDEN EAGLES IN NORTHEAST CALIFORNIA AND NORTHWEST NEVADA

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## Abstract

Between 1976 and 1981, 1,156 prey items representing 37 species were collected from Golden Eagle (*Aquila chrysaetos*) nests in the western Great Basin. The 4 most frequently encountered prey species were the black-tailed jackrabbit, mountain cottontail, yellow-bellied marmot, and Chukar. These species accounted for 90% of all prey items; the remains of livestock comprised less than 1%. Lagomorphs comprised 91% of the prey biomass; no other prey category species accounted for more than one percent of the total biomass.

## Introduction

The food habits of the Golden Eagle have been widely studied. Available data from North America were summarized by Olendorff (1976). We present data from an unstudied population of Golden Eagles in the western Great Basin of northeast California and northwest Nevada.

Golden Eagles have been persecuted throughout the western United States for their alleged depredations on domestic livestock. The discovery of large numbers of dead Golden Eagles in Wyoming during the early 1970's (Christopherson 1972) illustrated how severe this can be. As Olendorff (1976) points out, "eagles do, in fact kill livestock". However, the number of calves and lambs actually killed (versus scavenged) and the proportion that these animals represent in the diet should be considered when discussing the significance of Golden Eagle predation. Frequently overlooked, but perhaps of even greater significance to ranchers, is the proportion of lagomorphs and sciurids in the diet of Golden Eagles, because these major prey sources are competitors with livestock for available range forage (Vorhies and Taylor 1933).

## Study Area

The study area was a 13,800-km<sup>2</sup> portion of the western Great Basin and included parts of eastern Lassen and Modoc Counties of California, and western Washoe County, Nevada. Topography consists of north-south

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running ridges and isolated mountains separated by broad, flat valleys frequently containing dry alkali lake beds. It ranged from 1,220 m in the lowest valleys to 2,290 m on the highest peaks. Elevation of nest sites where prey remains were collected ranged from 1,295 to 1,905 m.

Primary natural vegetation associations are sagebrush steppe (*Agropyron-Artemisia*), saltbush-greasewood (*Atriplex-Sarcobatus*), and juniper steppe (*Juniperus-Artemisia-Agropyron*) woodland (Kuchler 1964). In addition to native forbs and grasses, introduced grasses, cheatgrass (*Bromus tectorum*) and medusa head (*Taeniatherum asperum*) are common.

### Methods

Food habits data were collected at nests in occupied eagle territories, 1976–1981 (Table 1). While food items found in nests are predominantly those brought to nestlings, some may also be remains of food consumed by adults. Collection of prey remains occurred between late April and mid-July each year. From a possible total of 59 territories, an average of 20 nests were sampled each year (Table 1). In most instances, the same territories were rechecked each year, but some were frequently inactive. When this occurred, adjacent territories were checked. In those cases where the eagles returned to the same territories each year, some nests were sampled for 5 of the 6 years. Most nests were examined only once per season. All prey remains, except carcasses representing fresh food for the nestlings, were removed.

To assess the dietary intake over the 6 year study period, prey biomass was tallied in a given year and the proportional contribution of individual prey species was calculated. Further, a combined figure of prey remains biomass and frequency is provided (Table 1).

Mammalian weights used in the estimation of biomass are reported in U.S. BLM (1979), Burt and Grossenheider (1976), Mitchell (1971), and Morrison (1945). Avian weights are provided by Dunning (MS), and reptile weights are reported in U.S. BLM (1979). Immature mammals for which no weights could be found were assigned weights based on probable identity and their approximate size. Although calves reportedly weigh an average of 30.6 kg (Morrison 1945), we used a figure of 4.13 kg (or the approximate weight that could be attributed to 1 to 2 feedings by a Golden Eagle), since the entire weight could not be carried to the nest. The 4.13 kg figure was used also because earlier scavenging by mammalian predators was evident. Because in most cases sex of the prey remains could not be determined, we used the mean of the two sexes, when presented separately in the literature, for our weight estimates of individual species. Domestic sheep were assumed to be young lambs for the purpose of biomass calculations (see Results).

Since frequency and biomass figures are derived from one nest visit (instead of repeated samples) they should be regarded as approximations. The number of items found in each nest ranged from 0 to 30 thus, other sources of bias may be present such as adults removing uneaten prey remains, or prey items being entirely consumed. However, in other studies (U.S. BLM 1979) the relative proportions of prey items found in 5 Golden Eagle nests were the same as those brought in during observations from a blind.

### Results

A total of 1,156 prey items representing 37 prey species were collected over a 6 year period (Table 1). Mammals made up 92% while birds and reptiles composed 6% and 2%, respectively. Over 90% of the diet of Golden Eagles consisted of lagomorphs and sciurids. The 4 most common prey species were the black-tailed jackrabbit (76%), mountain cottontail (9%), yellow-bellied marmot (3%), and Chukar (2%). All other species combined accounted for less than 6% of biomass.

Five of the 6 coyotes listed in Table 1 were young pups, and 3 were found in the same nest. The antelope and mule deer remains were all of animals estimated to be less than 2 weeks old. The 2 domestic cows reported were both calves, and 1 of 3 was clearly scavenged as evidenced by a crushed metapodal bone. Since Golden Eagles cannot crush even substantially smaller bones (i.e., the diameter of a human finger pers. obs.) it seems likely that the crushed metapodal suggests the calf died from trauma other than eagle predation. Sheep in the diet was inferred from the presence of wool in the nest, and the age of the individuals could not be determined. The Mountain Bluebird and Brewer's Blackbird, which frequently mob Golden Eagles, were presumably taken while harassing flying eagles.

Table 1. Prey remains found in Golden Eagle nests in northeastern California and northwestern Nevada.

1976 - 1981

(Number and percent of total)

| SPECIES**                    | 1976 |    | 1977 |    | 1978 |    | 1979 |    | 1980 |    | 1981 |    | I   |      | B     |      | Combined Totals |
|------------------------------|------|----|------|----|------|----|------|----|------|----|------|----|-----|------|-------|------|-----------------|
|                              | I%   | B% | I%   | B% | I%   | B% | I%   | B% | I%   | B% | I%   | B% | No. | (%)  | No.   | (%)  |                 |
| black-tailed jackrabbit      | 63   | 74 | 76   | 85 | 81   | 91 | 74   | 89 | 77   | 90 | 86   | 94 | 883 | (76) | 1,375 | (88) |                 |
| mountain cottontail          | 9    | 3  | 9    | 3  | 9    | 3  | 9    | 3  | 12   | 4  | 4    | 1  | 105 | (9)  | 105   | (3)  |                 |
| yellow-bellied marmot        | 6    | 2  | 2    | 1  | 2    | 1  | 5    | 2  | 3    | 1  | 2    | 1  | 39  | (3)  | 20    | (1)  |                 |
| unidentified ground squirrel | -    | -  | +    | +  | +    | +  | 2    | +  | +    | -  | 2    | +  | 11  | (1)  | 3     | (+)  |                 |
| California ground squirrel   | -    | -  | -    | -  | -    | -  | -    | -  | -    | -  | -    | -  | 1   | (+)  | 1     | (+)  |                 |
| Belding's ground squirrel*** | -    | -  | -    | -  | -    | -  | -    | -  | -    | -  | -    | -  | 3   | (+)  | 1     | (+)  |                 |
| muskrat                      | 1    | 1  | -    | -  | 1    | +  | -    | -  | -    | -  | 1    | +  | 1   | (+)  | 1     | (+)  |                 |
| bushy-tailed woodrat         | -    | -  | -    | -  | -    | -  | -    | -  | 1    | +  | -    | -  | 2   | (+)  | 1     | (+)  |                 |
| unidentified kangaroo rat    | -    | -  | -    | -  | -    | -  | -    | -  | +    | +  | -    | -  | 1   | (+)  | +     | (+)  |                 |
| montane vole***              | -    | -  | -    | -  | -    | -  | -    | -  | +    | +  | -    | -  | 1   | (+)  | +     | (+)  |                 |
| coyote                       | 3    | 5  | +    | 1  | -    | -  | -    | -  | -    | -  | 1    | 1  | 6   | (+)  | 12    | (1)  |                 |
| pronghorn                    | -    | -  | +    | 2  | -    | -  | -    | -  | 1    | 2  | -    | -  | 3   | (+)  | 11    | (1)  |                 |
| male deer                    | 1    | 4  | -    | -  | -    | -  | -    | -  | -    | -  | -    | -  | 1   | (1)  | 6     | (+)  |                 |
| badger                       | -    | -  | +    | 1  | -    | 1  | -    | -  | -    | -  | -    | -  | 2   | (+)  | 6     | (+)  |                 |
| porcupine                    | -    | -  | -    | -  | +    | +  | -    | -  | -    | -  | -    | -  | 1   | (+)  | 2     | (+)  |                 |
| domestic sheep               | -    | -  | +    | 2  | +    | 1  | +    | 1  | -    | -  | -    | -  | 3   | (+)  | 12    | (1)  |                 |
| domestic cow                 | +    | 2  | -    | -  | +    | 1  | -    | -  | -    | -  | -    | -  | 2   | (+)  | 8     | (1)  |                 |
| Sage Grouse                  | 1    | 1  | 2    | 3  | -    | -  | 1    | 2  | +    | 1  | -    | -  | 7   | (17) | 17    | (1)  |                 |
| Chukar                       | 1    | 1  | 1    | +  | -    | -  | 4    | 2  | 3    | 1  | 4    | 1  | 26  | (2)  | 15    | (1)  |                 |
| Ring-necked Pheasant         | 1    | 1  | -    | -  | -    | -  | -    | -  | -    | -  | -    | -  | 2   | (+)  | 2     | (+)  |                 |
| Caraback***                  | 1    | 1  | -    | -  | -    | -  | -    | -  | -    | -  | -    | -  | 1   | (+)  | 1     | (+)  |                 |

|                              |     |     |     |     |     |     |       |       |   |     |        |       |       |
|------------------------------|-----|-----|-----|-----|-----|-----|-------|-------|---|-----|--------|-------|-------|
| Mallard                      |     |     |     |     | -   | -   | -     | -     | - | -   | -      | 7 (+) | 8 (1) |
| Cinnamon Teal                |     |     |     |     | -   | -   | -     | -     | - | -   | -      | 2 (-) | 1 (+) |
| American Coot                | 3   | 1   | -   | -   | -   | 1 + | -     | -     | - | -   | -      | 4 (+) | 2 (+) |
| unidentified duck            | -   | + + | -   | -   | -   | -   | -     | -     | - | -   | -      | 1 (+) | 1 (+) |
| Western Grebe***             | -   | -   | +   | 1   | -   | -   | -     | -     | - | -   | -      | 1 (+) | 1 (+) |
| Barn Owl                     | 1   | +   | -   | -   | -   | -   | -     | -     | - | -   | -      | 1 (+) | +     |
| Long-eared Owl               | -   | -   | -   | -   | -   | -   | -     | -     | - | -   | -      | 5 (+) | 1 (+) |
| Great-horned Owl             | -   | -   | -   | +   | +   | 1 + | -     | -     | - | -   | -      | 1 (+) | 1 (+) |
| American Kestrel             | -   | -   | -   | -   | -   | -   | -     | -     | 1 | 1   | -      | 1 (+) | 1 (+) |
| Brewer's Blackbird***        | 1   | +   | -   | +   | -   | -   | -     | -     | - | -   | -      | 1 (+) | +     |
| Long-billed Curlew***        | 1   | +   | -   | -   | -   | -   | -     | -     | - | -   | -      | 1 (+) | 1 (+) |
| Black-billed Magpie          | 1   | 1   | -   | -   | -   | -   | -     | -     | - | -   | -      | 1 (+) | 1 (+) |
| Common Flicker               | -   | -   | +   | +   | +   | -   | 1 +   | +     | + | -   | -      | 5 (+) | 1 (+) |
| Mourning Dove                | -   | -   | -   | +   | +   | +   | +     | +     | + | -   | 3      | 1 (+) | +     |
| Mountain Bluebird***         | -   | -   | -   | -   | -   | -   | -     | -     | - | -   | -      | 1 (+) | +     |
| unidentified passerine       | -   | -   | -   | -   | -   | -   | +     | +     | + | -   | 2      | 1 (+) | +     |
| western yellow-bellied racer | 1   | +   | -   | -   | -   | -   | -     | -     | - | -   | -      | 1 (+) | +     |
| desert striped whipsnake***  | 1   | +   | -   | -   | -   | -   | -     | -     | - | -   | -      | 1 (+) | +     |
| gopher snake                 | -   | -   | 3   | +   | 1   | +   | 1 +   | +     | + | 1 + | 11 (1) | 2 (+) | 1 (+) |
| unidentified snake           | -   | -   | +   | +   | +   | 1 + | -     | -     | - | -   | 5      | 1 (+) | +     |
| Total Number of Individuals  | 129 | 171 | 224 | 237 | 284 | 111 | 1,156 | 1,567 |   |     |        |       |       |
| Total Number of Species      | 19  | 15  | 14  | 12  | 14  | 8   | 37    | -     |   |     |        |       |       |
| Number of Nests Examined     | 12  | 21  | 17  | 23  | 28  | 18  | 119   | -     |   |     |        |       |       |

° Percent of annual total: Individuals (I%), Biomass (B%), kg.

See Appendix 1 for scientific names.

\*\*\* Prey species previously unreported in the literature reviewed by Olendorff (1976).

+ Less than 1 percent.



### *Discussion*

The predominance of lagomorphs (85%) in the diet is nearly identical to that reported for the eastern Great Basin of Utah (87%) by Smith and Murphy (1979), and compares closely with the 91% reported by Craig (1974) for Colorado. Similarly, the percent biomass was highest for lagomorphs (91%) as was reported by Smith and Murphy (99%, 1979) and in southwest Idaho (70%, U.S. BLM 1979).

The low frequency of lagomorphs (54%) reported in Idaho (U.S. BLM 1979) is probably attributable to shifts in predation to locally abundant alternate prey species such as Ring-necked Pheasants (12%).

Some suggestions may be offered to account for annual differences in the number of prey species taken: (1) population fluctuations in key prey species, as shown by Smith and Murphy (1979), (2) individual adult or pair prey selectivity, and (3) yearly variation in extent of wetland habitat in the form of ephemeral dry lakes within eagle home ranges. In dry years the contribution of wetlands-associated prey, such as muskrat and ducks would be expectedly lower, thus influencing overall prey composition for those years.

The strongest case can be made for the influence of changes in major prey species availability. When jackrabbit intake was lowest (74% in 1976) overall species diversity in the diet was highest. Also in 1976, atypical prey such as the coyote and mule deer accounted for 9% of the total biomass. Conversely, when jackrabbit intake was highest (94% in 1981) annual prey species diversity was lowest. An overall pattern can be seen in the course of this study in which combined use of the 4 principal prey species decreased. Since annual biomass of jackrabbit prey varied by 20% between 1976 and 1981, and biomass of other principal prey items only varied 1 to 4% between high and low years, it is clear that jackrabbit availability has the strongest influence on annual prey item diversity. In years of low jackrabbit availability Golden Eagles apparently widen the diversity of prey items taken rather than increase the rate of predation on other key prey species such as cottontails and marmots. In Utah Golden Eagles similarly diversified their diets in years of low jackrabbit availability, but also proportionately increased their use of the other principal prey item, cottontails (Smith and Murphy 1979: Table 1).

While our data do not reflect the food habits of Golden Eagles throughout the year, they do span a substantial portion when young livestock are on the range. During the spring seasons in which this study was conducted, there was an average of ca. 9,000 sheep and 24,100 cows on the range each year (Schultz and Delaney pers. comm.); lambs and calves accounted for 64 and 44%, respectively, of these totals. Although we did not visit all Golden Eagle nests in the area, we believe our food habits data are representative of the eagles of the western Great Basin. Accordingly, our data show that for this area, the livestock portion of Golden Eagle diets are insignificant. In fact, in the western Great Basin where lagomorphs are competitors with livestock for range resources (Vorhies and Taylor 1933), Golden Eagles appear to exert a positive, rather than negative, influence on the livestock industry.

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### Appendix 1

Common and scientific names of the vertebrates listed in Table 1 are: mountain cottontail, *Sylvilagus nuttallii*; black-tailed jackrabbit, *Lepus californicus*; yellow-bellied marmot, *Marmota flaviventris*; unidentified ground squirrel, *Spermophilus* sp.; Belding's ground squirrel, *Spermophilus beldingi*; California ground squirrel, *Spermophilus beecheyi*; unidentified kangaroo rat, *Dipodomys* sp.; bushy-tailed woodrat, *Neotoma cinerea*; montane vole, *Microtus montanus*; muskrat, *Ondatra zibethicus*; porcupine, *Erethizon dorsatum*; coyote, *Canis latrans*; badger, *Taxidea taxus*; mule deer, *Odocoileus hemionus*; pronghorn, *Antilocapra americana*; Mallard, *Anas platyrhynchos*; Cinnamon Teal, *Anas cyanoptera*; Canvasback, *Aythya valisineria*; American Coot, *Fulica americana*; Chukar, *Alectoris graeca*; Ring-necked Pheasant, *Phasianus colchicus*; Sage Grouse, *Centrocercus urophasianus*; Mourning Dove, *Zenaidura macroura*; American Kestrel, *Falco sparverius*; Barn Owl, *Tyto alba*; Long-eared Owl, *Asio otus*; Great Horned Owl, *Bubo virginianus*; Common Flicker, *Colaptes auratus*; Black-billed Magpie, *Pica pica*; Brewer's Blackbird, *Euphagus cyanocephalus*; Mountain Bluebird, *Sialia currucoides*; western yellow-bellied racer, *Coluber constrictor*; desert striped whipsnake, *Masticophis lateralis*; gopher snake, *Pituophis melanoleucus*.

# NESTING HISTORY OF GOLDEN EAGLES IN MALHEUR-HARNEY LAKES BASIN, SOUTHEASTERN OREGON

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## Abstract

Historically, the Golden Eagle (*Aquila chrysaetos*) was a common breeding species and permanent resident of Malheur-Harney Lakes Basin since at least 1875. Incidental records on breeding territories were available from 1875 to 1980. Data were available from preselected breeding territories from 1966 to 1980. Eaglets fledging per occupied breeding territory fluctuated annually from 0.20 to 1.67. A total of 179 breeding territories were examined on or adjacent to Malheur National Wildlife Refuge. Our data agree with studies elsewhere which suggest a relationship between Golden Eagle reproductive success and abundance of their major prey species, the black-tailed jackrabbit (*Lepus californicus*). Nesting and fledging success are summarized for 1940, and 1966 through 1980.

## Introduction

Several unpublished Golden Eagle studies have been conducted in the Malheur-Harney Lakes Basin in southeast Oregon. Here we attempted to summarize past studies and present the nesting status for the species in the basin. Nesting surveys were conducted in 1940, and from 1966–1980. Incidental records on specific nests were available from 1875–1980. In 1966, The U.S. Fish and Wildlife Service initiated a study of Golden Eagles in southwest Idaho and southeast Oregon. This preliminary field work (Hickman 1968) began long term data collection on and adjacent to Malheur National Wildlife Refuge (NWR), Harney County, Oregon.

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### Study Area

Malheur-Harney Lakes Basin is in the northwest extremity of the Great Basin. It is composed of the High Lava Plains and Basin and Range Physiographic Provinces (Franklin and Dyrness 1973). The High Lava Plains Province is characterized by extensive basalt-rhyolite rimrock formations, while the Basin and Range Province consists of fault block mountains enclosing internal drainage basins. Elevation varies from 1227–1586 m (4025–5200 ft.).

The relatively flat lowlands are a mosaic of shrub uplands, freshwater marshes, seasonally wet meadows and alkali playas. Within the shrub upland native and introduced grasses are common. Dominant shrubs include big sagebrush (*Artemisia tridentata*), low sagebrush (*A. arbuscula*), black greasewood (*Sarcobatus vermiculatus*) and rabbitbrush (*Chrysothamnus* spp.). Freshwater emergents grow adjacent to the shrub upland in marshes. Wet meadows are composed of meadow grasses including timothy (*Phleum pratensis*), wildryes (*Elymus* spp.), meadow barley (*Hordeum hystris*), and red top (*Agrostis alba*). A unique feature of the basin is the extensive ecotone between the seasonal flooded wetlands and shrub uplands. Low rimrock cliffs 5–70 m high provide a sharp ecotone between sagebrush and wetland plant communities. Generally, the region resembles the Great Basin of northern Nevada and western Utah. Vegetation in some areas has been converted to alfalfa, cereal grains and crested wheatgrass. Many of the crested wheatgrass monotypic seedlings range from 800 to 3200 ha.

The climate is semi-arid, typical of the cooler portions of the Intermountain West. Most precipitation occurs from November through January principally in the form of snow. Water on all lakes and ponds, except those with warm springs, is usually frozen from late November through early February.

### Methods

Data were collected annually on an average of 11 (range 5 to 18) breeding territories from 1966–1979. In 1980, 33 territories were surveyed, 15 of which were associated with predominantly sagebrush and greasewood plant communities. Another 15 were associated with varying degrees of wetland habitat. Three were not used in the analysis comparing wetlands and rangelands because they could not be clearly classified into either community. Breeding territories were recorded as active or inactive. Breeding territories were considered unoccupied when no sign of territorial defense, courtship, or other related reproductive activities were noted after several visits. Both traditional and alternative nest sites were plotted on topographic maps and all known nests within a territory were examined annually. Most surveys were conducted on foot and by vehicle, but fixed-wing aircraft and helicopters were used at least 1 time a year. Field work began in February and continued through August. Additional observations were also noted for the remainder of the year, but not on a regular basis. Terminology used to describe reproductive success follows the definitions as defined by Postupalsky (1974).

Data collected in 1940, and 1966–1976 were analyzed by us. Additional data were collected by us during 1977–1980. Oologist records of egg sets and nest site descriptions were provided by the Western Foundation of Vertebrate Zoology (Lloyd Kiff pers. comm.). Field notes of William E. Griffie were also incorporated into this report.

### Results and Discussion

Historically, Golden Eagles have been a common breeding species in the basin since at least 1875 (Bendire 1877). The first nesting record was by Captain Charles Bendire (1877). He stated, "Golden Eagles are moderately abundant throughout the mountainous portions during the greater part of the year. Each pair appears to confine itself to a certain district and no others breed there. I have heard of several other nests in this vicinity at intervals of about twenty miles from the other. They are generally seen hunting in pairs in the early spring, chasing ducks, geese, and sagehens, and most successfully." Captain Bendire took eggs from a nest located in a ponderosa pine (*Pinus ponderosa*) on 9 April 1877 and 4 April 1878.

Willett (1919) also reported Golden Eagles as rather common in the mountainous sections surrounding the lake in 1918. In 1936, Jewett (Lloyd Kiff pers. comm.) located 2 large, downy young on 15 May 1934 near the present site of Krumbo Reservoir. Jewett also recorded the species as common on Steens Mountain (Jewett 1936).

William E. Griffie collected Golden Eagle egg sets annually within the basin from 1937-1942. In 1940, only 2 of the 7 nests that Griffie visited contained eggs. Two sites had single birds near their nests, but no eggs were present, and no nesting activity was noted at 3 other traditional sites. In 1941, of 6 nests traditionally visited, 4 contained eggs; 1 was decorated and ready for eggs with both birds in attendance; and 1 appeared deserted. Of the 4 occupied nests, 3 held sets of 3 eggs, while 1 had 2 eggs. He also recorded an unusually large number of 3 egg clutches in 1942. Black-tailed jackrabbits were extremely common in the spring of 1941 (Griffie).

The first documented study on Golden Eagles in the basin was conducted by Frank W. Groves (Refuge files). In 1940, Groves found all 7 sites he examined to be active. Four of the 7 sites fledged 6 young (0.86 fledged/occupied breeding territory; 1.5 fledged/successful nest).

Although few data were collected from 1950 to 1966, Golden Eagle populations were apparently low. John Scharff (Refuge files) stated, "There has been a 75 percent reduction in the Golden Eagle population in the Malheur NWR area since 1950." He postulated that the local population reduction was probably due to low jackrabbit populations, with a few eagles being shot. A large "jackrabbit crash" was recorded in 1950 (Refuge files).

Since 1966, traditional sites have been examined every year except 1975. Food habit data collected in 1940, 1966 and 1967 indicated Golden Eagles depend heavily on black-tailed jackrabbits as their primary prey during the nesting season (Table 1). Gabrielson and Jewett (1940) reported, "The Golden Eagle feeds largely on jackrabbits, but also takes waterfowl and other birds, all kinds of rodents, and possibly occasional lambs and fawns."

Table 1. Percent frequency of prey remains at Golden Eagle nesting sites in southeast Oregon (Malheur-Harney Lakes Basin).

| Prey Species                                              | %Frequency<br>1940 (Groves) | %Frequency<br>1966-67 (Hickman) |
|-----------------------------------------------------------|-----------------------------|---------------------------------|
| <b>Mammals</b>                                            | 78                          | 69                              |
| black-tailed jack rabbit<br>( <i>Lepus californicus</i> ) | 69                          | 49                              |
| Nuttall's cottontail<br>( <i>Sylvilagus nuttallii</i> )   | 4                           | 12                              |
| yellow-bellied marmot<br>( <i>Marmota flaviventris</i> )  | 5                           | 2                               |
| Other Mammals                                             | 0                           | 6                               |
| <b>Birds</b>                                              | 22                          | 29                              |
| dabbling ducks<br>( <i>Anas</i> spp.)                     | 20                          | 9                               |
| Other Birds                                               | 2                           | 20                              |
| <b>Other Species</b>                                      | 0                           | 2                               |
| <b>TOTAL</b>                                              | <b>100</b>                  | <b>100</b>                      |

McAdoo and Young (1980) stated that jackrabbit populations are cyclic. Wagner and Stoddart (1972) reported that black-tailed jackrabbits normally experience cyclical population fluctuations with 4 or 5 years of population decline (1962 to 1967), followed by 3 successive years of population increase. In west-central Utah, Murphy (1975) reported that rabbit densities were moderately low in 1967, rose to a peak in 1969, then began a precipitous decline falling to very low levels in 1973. Kochert (1980) assumed that in southwest Idaho jackrabbit numbers peaked in 1970 or early 1971. Jackrabbit populations in southwest Idaho declined in 1972 and reached a low level in 1973, 1974, and 1975. By 1976–1978, their numbers had increased but were still below 1971 levels. The timing of our subjective jackrabbit “highs” and “lows” approximate those of Murphy and Kochert. A “jackrabbit crash” occurred in the Malheur-Harney Lakes Basin during the winter of 1972–1973 (Littlefield 1976). Several investigators (Palmer 1897; Nelson 1909; Clark 1972; Wagner and Stoddart 1972; Newton 1979; McAdoo and Young 1980) suggest a 7–10 year jackrabbit population cycle. Low and high populations are evident by their scarcity and abundance. Our subjective rabbit estimates suggest that 7–10 year cycles also occur in the Malheur-Harney Lakes Basin.

Murphy (1975) and Kochert (1980) found that fledging rates in Utah and Idaho closely followed fluctuations in jackrabbit populations. Kochert (1980) found nestling survival declined markedly from good to poor jackrabbit years. Kochert reported decreases in the percent of successful pairs, number of young fledged per successful attempt, and number of young fledged per pair. In southeast Oregon, we believe the most reliable indicators of Golden Eagle production were fledglings per pair and the percent of traditional eyries which were successful in fledging at least 1 young (Table 2, Fig. 1). Eagle reproductive success closely paralleled our subjective estimates of jackrabbit frequency.

Table 2. Golden Eagle breeding data 1940, 1966–80 in southeast Oregon; sample size (n) in parentheses.

| Year Occupied | # Fledged Per Breeding Territory | # Fledged Per Successful Nest | # Successful Nests<br># Breeding Territories Checked |
|---------------|----------------------------------|-------------------------------|------------------------------------------------------|
| 1940          | 0.86 (7)                         | 1.50 (4)                      | 57% (7)                                              |
| 1966          | 1.00 (6)                         | 1.50 (4)                      | 57% (7)                                              |
| 1967          | 1.40 (10)                        | 1.75 (8)                      | 73% (11)                                             |
| 1968          | 1.60 (5)                         | 2.00 (4)                      | 57% (7)                                              |
| 1969          | 1.67 (6)                         | 1.67 (6)                      | 66% (9)                                              |
| 1970          | 1.00 (8)                         | 1.60 (5)                      | 45% (11)                                             |
| 1971          | 0.89 (9)                         | 2.00 (4)                      | 40% (10)                                             |
| 1972          | 0.50 (10)                        | 1.67 (3)                      | 27% (11)                                             |
| 1973          | 0.20 (10)                        | 2.00 (1)                      | 8% (13)                                              |
| 1974          | 0.55 (11)                        | 2.00 (3)                      | 25% (12)                                             |
| 1975          |                                  |                               |                                                      |
| 1976          | 1.00 (8)                         | 1.60 (5)                      | 55% (9)                                              |
| 1977          | 1.50 (8)                         | 2.00 (6)                      | 60% (10)                                             |
| 1978          | 1.62 (13)                        | 1.75 (12)                     | 75% (16)                                             |
| 1979          | 1.06 (16)                        | 1.42 (12)                     | 71% (17)                                             |
| 1980          | 1.39 (18)                        | 1.67 (15)                     | 83% (18)                                             |
| Pooled Mean   | 1.08 (145)                       | 1.70 (92)                     | 51% (179)                                            |

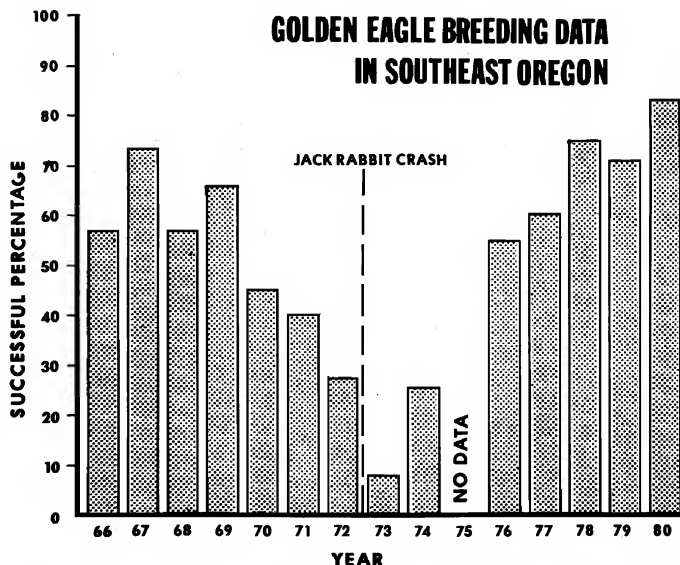


Figure 1. Golden Eagle reproduction data, Harney Co., Oregon. Percentage of Golden Eagle pairs fledging at least one successful young from 1966-1980.

The percentage of breeding territories which were successful in fledging at least one young were higher in years when jackrabbit populations appeared high. In contrast, eagles were less successful when jackrabbits appeared scarce (Fig. 1). Murphy (1975) found in low prey years, even though fewer pairs breed, there is a high potential for success on the part of those which do nest. Our data support Murphy's conclusions.

Within the basin, approximately 50,587 ha of native range have been converted to crested wheatgrass (G. Wing pers. comm.). For the past 7 years, approximately 1215 ha per year, of sagebrush and greasewood, have been cleared and converted to cereal crops or alfalfa (Paul Friedrichsen pers. comm.). Brush species provide escape cover to jackrabbits from aerial predators such as Golden Eagles. The ability of brush species to store water during winter and early spring months may be as important to jackrabbit survival as escape cover. Water is known to be important, with most workers agreeing that jackrabbits select succulent vegetation (Hansen and Flinders 1969). In northern Utah, Westoby (1980) found shrubs, such as sagebrush and greasewood, were commonly selected in the jackrabbit's diet because of their relatively high water content. Sagebrush was a large proportion of their diet from the beginning of shrub dormancy (November) until new growth began in April. This may explain why breeding territories associated with large blocks of monotypic vegetation, such as crested wheatgrass and agricultural areas, were not as successful as sites with a mosaic of native vegetation. Because Golden Eagles are permanent residents within the basin, it is important that substantial areas re-



main in native vegetation. Small monotypic stands of agriculture and crested wheatgrass within a breeding territory may increase diversity, thereby increasing the prey base.

Several workers (Perrins 1969; Krapu 1979; Newton 1979) have discussed the need for proper nutrition of adult birds before egg laying and incubation. It seems logical that pairs associated with wetland habitat should have an available food supply to exploit during the critical winter months prior to egg laying and incubation that is not available in the shrub uplands. In 1980, additional breeding territories were examined, bringing the total checked to 33. Fifteen were associated with predominantly sagebrush and greasewood plant communities and another 15 were adjacent to wetland plant communities. In 1980, the mean number of fledglings per occupied breeding territory was 1.07 in sagebrush and greasewood communities as compared to 1.67 fledged per occupied territory associated with varying degrees of wetland habitat. These data were significant ( $t = 2.40$ ;  $p < .05$ ) indicating eagles were more productive adjacent to wetlands. The low elevation wetland areas attract migratory waterfowl, upland game birds, mule deer (*Odocoileus hemionus*), jackrabbits, and usually large populations of wintering livestock (Refuge files).

The amount and quality of wetlands within breeding territories varied. During winter, prey appeared to concentrate near wetland lowlands. Thus, pairs associated with wetland habitat may have an abundant food supply prior to egg laying. When jackrabbit numbers were low or declining Golden Eagles pairs in territories associated with sagebrush and greasewood plant communities and no wetlands would be forced to exert more energy to obtain food. The apparent difference in potential prey frequency is one possible explanation for the differences noted in reproductive success between occupied breeding territories adjacent to wetlands and those inhabiting homogeneous rangelands in 1980.

Of data collected on 179 breeding territories over a 15 year period, the fate was determined on 145 (Table 2). Ninety-two (63%) of the 145 of known fate were successful in raising at least 1 young. In our study area, 156 eaglets fledged from 107 occupied breeding territories (1.46 eaglets fledged/occupied territory). Eaglets fledged per successful nest was slightly higher, with 1.70 fledged per successful nest (156 eaglets fledged/92 successful nests). These data are very comparable to other long term studies in Scotland and Idaho (Watson 1957, USDI 1979).

### *Acknowledgements*

In a long term study you accumulate a large list of people who have assisted in data collection. We thank Burns District Bureau of Land Management personnel Ginny Rosenburg, Guy Sheeter, Larry Todd and Gary Wing. Personnel of the Oregon Department of Fish and Wildlife were helpful, especially Ellis Mason and Jim Torland. We appreciate the several biologists associated with Malheur NWR. Significant contributions were received from John Cornely, Larry Ditto, Harold Duebbert, Frank Groves, Gary Ivey, Gene Kridler, Dave Marshall, Eldon McLaury, Larry Napier, John Scharff and Dick Sjostrom. We thank Lloyd Kiff of the Western Foundation of Vertebrate Zoology for data on specific nests. William E. Griffie's field notes and personal communications provided special insights. We thank John Cornely, Brad Ehlers and Joe Mazzoni for reviewing and improving this manuscript and Ruth Warneke for typing. This manuscript was improved by the comments of referees Mark Fuller, Joseph Murphy, and David Ellis.



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# NOTES ON GOLDEN EAGLE PRODUCTIVITY AND NEST SITE CHARACTERISTICS, PORCUPINE RIVER, ALASKA, 1979-1982

by

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## Abstract

Nesting Golden Eagles were observed along the Porcupine River, Alaska between 1979 and 1982. Thirty-seven nests were described in relation to exposure, height, substrate, and productivity. Nest sites were generally oriented S or SE (57%) and except for one tree nest, occurred on large cliff faces. The number of active nests ranged from 3 in 1980 to 9 in 1982. Active nests in 1982 were spaced an average of 15.3 km apart. Productivity for all three years averaged 1.5 young per successful nest. Incubation probably occurs as early as mid April. Prey at nests varied and included hare, ground squirrel, and muskrat. Comparisons with other Golden Eagle populations in North America are presented.

## Introduction

The Golden Eagle, *Aquila chrysaetos*, is a locally common raptor in mountainous regions of Alaska. Nest sites in northern and interior Alaska have been inventoried during petroleum industry investigations, Peregrine Falcon surveys, and other raptor censuses (i.e., Ritchie 1977; White *et al.* 1977). Aspects of the species breeding biology are scattered in these survey reports and miscellaneous published notes (Hobbie and Cade 1962; Campbell 1960; Hatler 1974; Bailey 1979).

Nesting activities of Golden Eagles were observed along the Porcupine River, Alaska, between 1979-1982. Data on productivity, nest site characteristics, food habits and estimated phenology were gathered. This paper summarizes these data previously reported in 4 unpublished reports to the U.S. Fish and Wildlife Service (Curatolo and Ritchie 1979; Ritchie and Curatolo 1980, 1981; Ritchie 1982).

## Study Area

The study area consisted of the Porcupine River and adjacent cliffs, bluffs, and lowlands between the Alaska-Yukon Territory border and John Herbert Village, a distance of approximately 145 km. The river crosses the Porcupine Plateau region of the Northern Plateau Province (Wahrhaftig 1965) creating numerous riparian cliffs. Elevations range from 200 m to 600 m.

Vegetation has been markedly influenced by fire. Nearly the entire study area has been burned within the past 25 years. Fires have created a mosaic of aspen, *Populus tremuloides*, birch, *Betula papyrifera*, and spruce, *Picea* spp. South slopes also contain large tracts of grass and sagebrush, *Artemisia* spp. Gravel bars, islands, and north-facing slopes are covered with willow, *Salix* spp. and alder, *Alnus rubra*.

The Porcupine River has had a history of use as a transportation corridor for aboriginal settlements and trade. Human use today is predominantly low density recreation and trapping.

## Methods

Surveys were made by boat on the Porcupine River between late June and mid-July in all study years. In 1979 all cliff habitat was checked for eagle nests with binoculars and/or spotting scopes. Nest sites were mapped on U.S. Geological Survey 1:63,360 topographic maps and surveyed for occupancy and productivity dur-

ing all 4 years. Nest sites were described in relation to their exposure, substrate, activity, and productivity. Productivity was described as the number of large nestling (3 to 6 weeks old) per nest. Seven nestlings were banded in 1981; eleven young were banded in 1982. Estimates of nesting phenology were made assuming that incubation and nestling stages were roughly 40+ and 65+ days, respectively (Brown 1976). Prey remains were collected and identified at 4 nests in 1981, and 8 nests in 1982.

### Results and Discussion

Thirty-seven nests were located between 1979–1982. During 1980 1 nest was destroyed and 2 were constructed. Thirty-six nests were located on sheer cliffs and pinnacles, accessible only by rope. They ranged from approximately 20 m–125 m above the river. One additional nest was located in a white spruce, *Picea glauca*. Although Golden Eagles regularly nest in trees in other parts of their North American range (Dixon 1937; McGahan 1968; Beecham and Kochert 1975), records of nests in trees are limited in Alaska (White 1974, unpubl. notes). All but two nests were large and obvious masses of branches; these were inconspicuous and situated on broad rock ledges, similar to a site described by Campbell (1960) in the Brooks Range.

Thirty-one (84%) nests were within 100 m of the river. The remaining 6 (16%) were on cliffs fronted by wooded terraces but still within 400 m of the river. Twenty-one (57%) nests were oriented in a south or southeastern direction (Figure 1). These orientation data are similar to those of Mosher and White (1976) who found that Alaskan nest sites generally faced southeast. They hypothesized that this exposure was explainable on the basis of temperature-dependent nest site selection by cliff-nesting Golden Eagles.

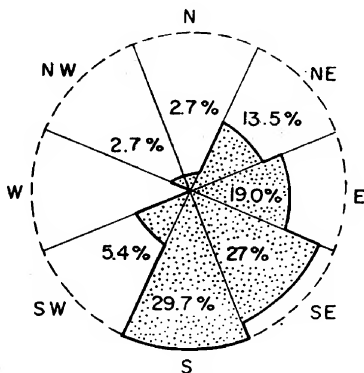


Figure 1. Compass orientation of Golden Eagle nest sites, Porcupine River, Alaska, 1979–1981.

Productivity in the study area ranged from 1.3 young per successful nest to 1.6 young per successful nest between 1979 and 1982. Productivity averaged 1.5 young per successful nest, (Table 1). Golden Eagle productivity data for other regions in Alaska are limited: 1.8 yg per successful nest for an area adjacent to the Trans-Alaska Pipeline ( $n=10$ ) (White 1974); 1.7 yg per successful nest in the northwestern foothills of the

Table 1. Productivity of Golden Eagles, Porcupine River, Alaska, 1972–1982.

| Year | Number of Young | Number of Successful Nests | Number of Young per Successful Nests | Number of Nests With |      |      |
|------|-----------------|----------------------------|--------------------------------------|----------------------|------|------|
|      |                 |                            |                                      | 1 yg                 | 2 yg | 3 yg |
| 1979 | 7               | 5                          | 1.40                                 | 3                    | 2    | 0    |
| 1980 | 4               | 3                          | 1.33                                 | 2                    | 1    | 0    |
| 1981 | 12              | 8                          | 1.50                                 | 5                    | 2    | 1    |
| 1982 | 14              | 9                          | 1.60                                 | 5                    | 3    | 1    |

Brooks Range ( $n = 10$ ) (Ritchie 1977); and 1.6 yg per successful nest in the Mt. McKinley area ( $n = 8$ ) (Murie 1944).

The timing of our surveys precluded a determination of early nestling loss characteristic of eagles. Instead, nestling numbers may more closely approach the number of young fledged. In other North American studies mean brood size per successful nest decreased from 1.8 to 1.6 between hatching and fledging in Idaho (Beecham and Kochert 1975) and Montana (McGahan 1968).

Seven nestlings were banded in 1981. There was as much as 4 or 5 weeks difference in nestling ages. The breeding phenology in 1981, based on all nestlings observed, was estimated as follows: onset of laying (10 April to 15 May); hatching (25 May to 25 June); and, fledging (25 July to 1 September). In 1982 all hatching had probably occurred by mid-June. Most pairs were probably incubating by late April in 1981 and 1982. Dixon (1938) recorded eagles on eggs as early as 8 April and Campbell (1960) estimated that eagles in the central Brooks Range must incubate as early as the end of April or early May, and that hatching probably occurs in early June.

Golden Eagles are early spring migrants in interior Alaska and have been observed in mid-March in the Brooks Range (Irving 1960, unpubl. notes). Bent (1961) recorded them as occasionally wintering in western Alaska and late winter records elsewhere in the state support this premise (D. Gibson, pers. comm.). A local trapper observed them in late February in the study area in 1981 (R. Carrol, pers. comm.).

Successful nests ranged from 2–59 m apart in 1982, a mean linear density of one pair per 15.3 km of river. Beecham and Kochert (1975) located pairs at 5 and 8 km intervals on an Idaho river in two different years. Nests on the Tanana River, Alaska averaged one pair per 13.5 km (unpubl. notes). The lower density in our study is partly due to one section of river which does not have suitable cliff habitat (ca. 40 km) as well as lower eagle numbers.

Ten prey species were identified in nests in 1981 and 1982; their frequency of occurrence is listed in Table 2. Varying hare (*Lepus americanus*) and Arctic ground squirrel (*Citellus parryi*) predominated in both years. Only the pike, *Esox lucius*, a common fish in the Porcupine River, has not been recorded in northern Golden Eagle nests. Other fish species, however, have been identified at North American Golden Eagle nests (Olendorff 1976).

Besides those species listed above, food items at nests in Alaska have included marmot, *Marmota caligata* (Murie 1944; unpubl. notes), microtines and ptarmigan, *Lagopus* spp. (Murie 1944; Hatler 1974), short-tailed weasel, *Mustela erminea*, Gray Jay, *Perisoreus canadensis*, Harlequin Duck, *Histrionicus histrionicus* (Hatler 1974), caribou, *Rangifer tarandus*, Dall sheep, *Ovis dalli* (Murie 1944), murre, *Uria* spp. (Swartz 1966;

Table 2. The occurrence of potential prey species in Golden Eagle nests, Porcupine River, Alaska, 1981 and 1982.

| Prey Species                                         | 1981   |      | 1982   |      | Combined |      |
|------------------------------------------------------|--------|------|--------|------|----------|------|
|                                                      | Number | %    | Number | %    | Number   | %    |
| Varying hare<br><i>Lepus americanus</i>              | 11     | 55.0 | 28     | 60.8 | 39       | 59.1 |
| Arctic ground squirrel<br><i>Citellus parryi</i>     | 8      | 40.0 | 10     | 21.7 | 18       | 27.3 |
| Muskrat<br><i>Ondatra zibethicus</i>                 | 1      | 5.0  | 2      | 4.3  | 3        | 4.5  |
| Yellow-cheeked vole<br><i>Microtus xanthognathus</i> |        |      | 1      | 2.2  | 1        | 1.5  |
| Marten<br><i>Mustela americana</i>                   |        |      | 1      | 2.2  | 1        | 1.5  |
| Unidentified duck<br><i>Anas</i> spp.                |        |      | 1      | 2.2  | 1        | 1.5  |
| Herring Gull<br><i>Larus argentatus</i>              |        |      | 1      | 2.2  | 1        | 1.5  |
| Unidentified passerine                               |        |      | 1      | 2.2  | 1        | 1.5  |
| Northern Pike<br><i>Esox lucius</i>                  |        |      | 1      | 2.2  | 1        | 1.5  |
|                                                      | 20     | 100  | 46     | 100  | 66       | 100  |

Drury 1977, 1978; Springer and Roseneau 1978), and kittiwakes, *Rissa* spp. (Drury 1978). All of these species, with the exception of seabirds, are probably available to Golden Eagles along the Porcupine River during breeding season.

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## **SPATIAL RELATIONSHIPS OF NESTING GOLDEN EAGLES IN CENTRAL UTAH**

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### **Abstract**

We examined the distribution of Golden Eagle (*Aquila chrysaetos*) nest sites in the eastern Great Basin using the Clark-Evans nearest-neighbor method of analysis. Distribution values indicated uniform spacing of nest sites within the hills and ridges, which provided all of the potential nesting sites in the study area. Analysis of Golden Eagle nest site distribution with three other large raptors suggested a tendency toward uniform spacing between diurnal raptor species and aggregation with the Great Horned Owl (*Bubo virginianus*).

### **Introduction**

Odum (1971) suggested that populations exhibit one of three distribution patterns: (1) random, where habitat is homogenous and individuals do not normally interact; (2) uniform, where habitat is homogenous and individuals compete for one or more resources; (3) aggregated, that may result from either heterogenous habitat or a tendency to aggregate socially. Newton (1979) noted that many species exhibit uniform distribution of territories and nest sites except where available sites are limited and concentrated, such as in the Snake River Birds of Prey Natural Area. Our observations of Golden Eagles in the eastern Great Basin Desert revealed a concentration of nest sites in high, north-south oriented ridges and hills but none in intervening broad, flat valleys. Herein we examine this distribution using the Clark-Evans nearest-neighbor model (1954).

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### Study Area

We began long term raptor studies on a 7700 km<sup>2</sup> portion of the eastern Great Basin Desert in 1966. Data used herein are from a 120 km<sup>2</sup> segment of the area which includes portions of Utah and Tooele Counties. We have described the climate, topography and major vegetation of the study area previously (Smith and Murphy 1973).

### Methods

Our studies were from 1966–1970. Details of methods are provided in Smith and Murphy (1973).

The Clark-Evans model is a measure of the ratio (R) of the distance between nearest-neighbor sites ( $\bar{r}_A$ ), in this case active eagle nests, to the theoretical nearest-neighbor distance ( $\bar{r}_E$ ) expected if all nests were in fact uniformly distributed:

$$R = \bar{r}_A / \bar{r}_E$$

where  $\bar{r}_A$  is the average of the observed distances,  $\bar{r}_A = \Sigma \text{distances} / N$  and  $N$  is the total number of distances sampled. The theoretical value,  $\bar{r}_E$ , is determined,  $\bar{r}_E = 1/2\sqrt{p}$  where  $p$  is the population density expressed as the number of active nests per unit of area. The calculated  $R$  indicates the spatial pattern of distribution. If random,  $R$  equals or approaches 1; if aggregated  $R$  equals or approaches 0; if uniform  $R$  equals or approaches 2.15. The significance of the calculated  $R$  is tested by the following:

$$C = \bar{r}_A - \bar{r}_E / \sigma_{\bar{r}_E}$$

where  $C$  is the standard variate of the normal curve and  $\sigma_{\bar{r}_E}$  is the standard error of the average distance to the nearest-neighbor in a randomly distributed population of density  $p$ . This may be determined as follows:

$$\bar{r}_E = 0.26136 / Np$$

The 5% and 1% significance levels are represented by  $C$  values of 1.96 and 2.58 respectively for a two-tailed test.

The Clark-Evans model requires knowledge of the breeding density of the species. Golden Eagles and other large raptors in central Utah nested primarily in foothills and ridges and hunted in the valleys. Large tracts of these valleys were not used by the collective raptor population during the nesting season. In 1969 and 1970, we determined minimum home ranges of Golden Eagles and other raptors on a smaller 120 km<sup>2</sup> of the original study area by observation of movements of each nesting pair from blinds. We observed each pair a minimum of 10 hrs over several days. The area of the combined Golden Eagle home ranges was considered the ecological density and included in the calculations. Miller and Stephen (1966) used this method to examine spatial relationships of individuals in feeding flocks of Sandhill Cranes (*Grus canadensis*) with the Clark-Evans model.

### Results and Discussion

Distribution of active nests of the Golden Eagles, Great Horned Owl, Ferruginous Hawk (*Buteo regalis*), and Red-tailed Hawk (*Buteo jamaicensis*) on the 120 km<sup>2</sup> area are shown in Figure 1.

In 1969 and 1970, nearest-neighbor distances between the 34 active Golden Eagle nests averaged  $4.3 \pm 1.33$  km and ranged from 1.7 km to 5.1 km.

Comparatively, nearest-neighbor distances between the 34 active Golden Eagle nests located on the entire 1170 km<sup>2</sup> area from 1967–1970, were slightly, but not significantly less, averaging  $3.71 \pm 1.1$  km (range 1.12 km to 10.3 km). Nearest active nests were usually located on opposite sides of high ridges and pairs hunted primarily in opposite valleys. For example, in 1968, nests of 3 pairs in the foothills south of Lake Mountain formed a triangle 1.12 km, 2.4 km and 2.4 km on the three sides. Caminzand (1969) noted that the 2 nearest nests of this triangle were separated by a ridge 38.1 m higher than either nest site. Adults at these 3 nests reportedly occupied separate hunting ranges. These observations coupled with the distribution patterns illustrated in Figure 1



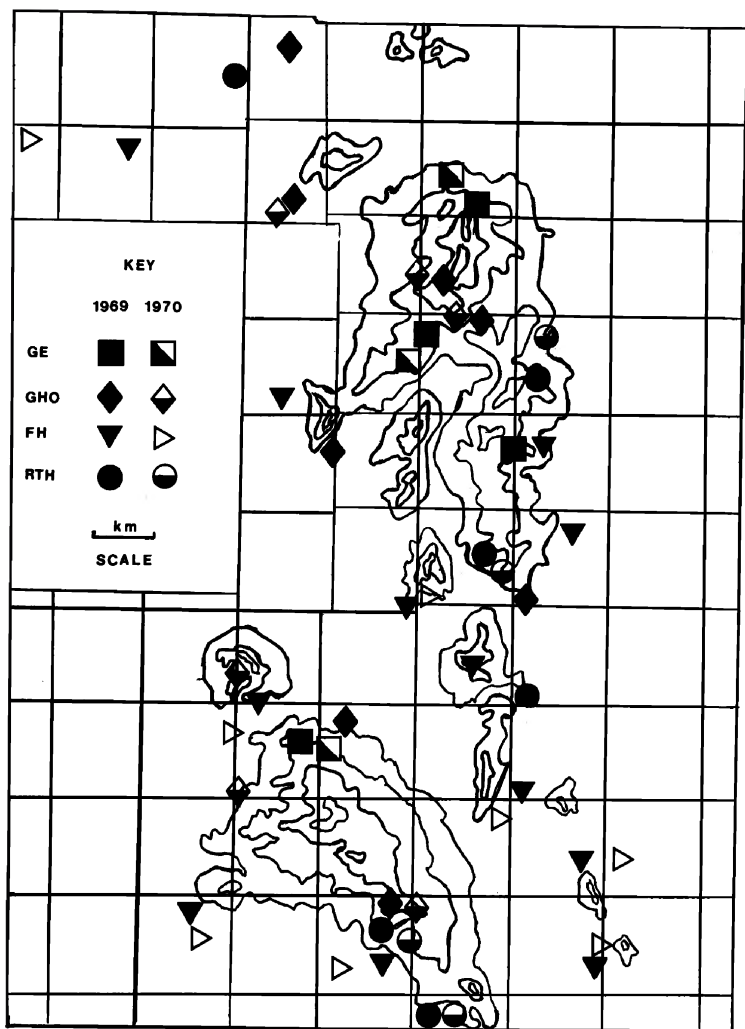


Figure 1. Distribution of active nests of Golden Eagles (GE), Great Horned Owls (GHO), Ferruginous Hawks (FH) and Red-tailed Hawks (RTH) on a 120 km<sup>2</sup> portion of the central Utah study area in 1969 and 1970.

suggest an aggregated pattern of nest placement resulting from the limited potential nest site habitat. Results of nearest-neighbor analysis of Golden Eagle nest distribution do not however indicate an aggregated pattern (Table 1). For comparison, we have included analysis of Golden Eagles with 3 other large raptors nesting on the study area.

Table 1. Analysis of nest site distribution of Golden Eagles and other large raptors in central Utah.

|       | Golden Eagle |      | Golden eagle X<br>Great Horned Owl |       | Golden Eagle X<br>Ferruginous Hawk |       | Golden Eagle X<br>Red-tailed Hawk |      |
|-------|--------------|------|------------------------------------|-------|------------------------------------|-------|-----------------------------------|------|
|       | 1969         | 1970 | 1969                               | 1970  | 1969                               | 1970  | 1969                              | 1970 |
| N     | 4            | 3    | 8                                  | 6     | 12                                 | 7     | 6                                 | 4    |
| $r_A$ | 3.28         | 2.57 | 0.82                               | 1.26  | 1.98                               | 2.29  | 2.32                              | 2.28 |
| $r_E$ | 2.20         | 3.15 | 1.43                               | 1.58  | 2.34                               | 1.41  | 1.86                              | 1.81 |
| R     | 1.49         | 0.82 | 0.57**                             | 0.79* | 0.84                               | 1.62* | 1.24*                             | 1.15 |

\*Significant at  $P < 0.05$

\*\*Significant at  $P < 0.01$

Distribution values of Golden Eagle active nests in 1969–1970, were  $R = 1.49$  and  $R = 0.82$  respectively. The 1969 value indicates a trend towards uniform spacing of nests while the 1970 value shows random spacing. The analysis does not suggest aggregation, even with the restricted area of potential nest sites.

Distribution of active Golden Eagle and Great Horned Owl nests had values of  $R = 0.57$  in 1969 and  $R = 0.79$  in 1970. Both values are statistically significant ( $p < 0.05$ ) and indicate a trend towards aggregation, undoubtedly a function of similarity in choice of nest sites by the two species plus lack of interaction because of differing daily activity patterns. Distribution of active Golden Eagle and Ferruginous Hawk nests had values of  $R = 0.84$  in 1969 and  $R = 1.62$  in 1970. These values indicate random nest location in 1969 and a trend towards uniform spacing in 1970. Comparative values of Golden Eagle and Red-tailed Hawk nest distribution were  $R = 1.24$  in 1969 and  $R = 1.15$  in 1970. Both values suggest a trend towards uniform spacing.

Golden Eagles nested in cliffs or rock outcrops at elevations ranging from 1460–1910 m, although most were located at elevation greater than 1680 m. Great Horned Owls nested in cliffs and junipers at elevations ranging from 1485–1890 m. Distances between active Golden Eagle and Great Horned Owl nests averaged 1.12 km. The nearest active nests were 0.08 km apart in the same quarry cliff face while the most distant was 2.45 km. Red-tailed Hawks selected nest sites in several cliff types and trees at elevations ranging from 1508–1847 m. Distances between active nests of Golden Eagles and Red-tailed Hawks ranged from 1.34 km to 4.26 km and averaged 2.45 km, considerably greater than those between Great Horned Owls and Golden Eagles.

Nests of Ferruginous Hawks were located on rock outcrops and in a variety of tree and ground sites at middle and lower elevations. A total of 85.1% were found between 1511–1660 m and none were at elevations higher than 1710 m. Distances between active nests of Golden Eagles and Ferruginous Hawks averaged 2.45 km and ranged from 0.88 km to 4.04 km.

There is an apparent correlation between daily activity patterns of the four raptor species and distribution of active nests. Thus the two raptors with the least similar daily activity patterns, Golden Eagles and Great Horned Owls show an aggregated distribution pattern when considered together. The two raptor species with the greatest similarity in daily activity patterns, Golden Eagles and Red-tailed Hawks, show a trend towards uniformity of distribution of active nests, suggesting interaction to at least some degree during nest site selection. The spacing of Golden Eagle and Ferruginous Hawk active nests is more random and may reflect the somewhat crepuscular activity of the Ferruginous Hawk.

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## OBSERVATIONS OF GOLDEN EAGLES NESTING IN WESTERN WASHINGTON

by

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Nesting of the Golden Eagle (*Aquila chrysaetos*) west of the Cascade Mountains in Washington State generally has been considered rare, and more commonly has been identified with the open habitats of the arid country of eastern Washington (Dawson and Bowles 1909, Jewett *et al.* 1953, Alcorn 1978). However, Laing (1956) recorded nesting Golden Eagles on Vancouver Island, British Columbia, and Thomas (1977) noted

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probable nesting of Golden Eagles in western Oregon. In western Washington, Retfalvi (1963) observed adult and juvenile Golden Eagles on San Juan Island, Eaton (1976), reported 6 possible nest locations, and Servheen (1978) located an active nest on the west slope of the Cascade Mountains. By the summer of 1981, 21 nests in 13 territories had been reported to the Nongame Wildlife Program of the Washington Department of Game.

The nesting territories were widely distributed: 4 (with 5 nests) were on the western slopes of the northernmost Cascade Mountains; 4 (with 10 nests) in southwestern Washington; 3 (with 4 nests) on the Olympic Peninsula; and 2 (with 2 nests) in the San Juan Islands. We began systematic activity and productivity surveys in 1977, and have observed activity at 11 territories at least once in the past 5 years.

We have not been able to discern any particular pattern of use of territories or of alternate nests within territories. Boeker and Ray (1971) noted that patterns of territory and nest use by eagles in the southwestern United States varied widely among pairs, and we observed similar variation in western Washington. For example, one pair apparently nested in alternate years, another nested in alternate years in successive years, and a third used the same nest for 4 years.

Of the 13 territories, 12 contain 20 nests located in Douglas-fir (*Pseudotsuga menziesii*), with the remaining nest on a cliff. We have numerous observations at 18 of the tree nests, and found that 17 were located at or below canopy height in trees near the edges of forest stands or in small stands of trees adjacent to clearcuts or open fields. This is consistent with findings of Anderson and Bruce (1981), who noted that Golden Eagle tree nests in western Washington often were distinguishable from Bald Eagle (*Haliaeetus leucocephalus*) nests. Golden Eagle nests tended to be smaller in size than those of Bald Eagles, were located on or very near the edge of a forest stand, and were located at or below the average canopy height. Bald Eagle nests were located at or above the canopy level, within the forest stands, and were nearer water than Golden Eagle nests. One Golden Eagle nest, unlike the others, was found in a dense forest stand overlooking Puget Sound, a habitat more typical for Bald Eagle nesting. This nest tree contained an active Bald Eagle nest in 1979, and an unsuccessful Golden Eagle nest in 1980.

All of the Golden Eagle nests we observed were adjacent to or no more than 500 m from large clearcuts or open fields, which support populations of medium-sized mammals such as mountain beaver (*Aplodontia rufa*), snowshoe hare (*Lepus americanus*), and European rabbit (*Oryctolagus cuniculus*). Servheen (1978) previously reported Golden Eagles preying on mountain beaver, and we found them, snowshoe hare, and unidentified bird remains at several nests. Additional prey species in the diet remain to be determined.

Golden Eagles likely have been present in small numbers for centuries in western Washington where fire provided necessary habitat. Thomas (1977) and Servheen (1978) suggested that clearcut logging creates highly favorable Golden Eagle habitat by providing large, open areas, that support prey species. This suggestion parallels the speculations by Leopold and Wolfe (1970) that the conversion of forestlands to pastures has created an improved habitat for Wedge-tailed Eagles (*Aquila audax*) in south-eastern Australia. Because modern forest practices increasingly have employed the clearcut method in western Washington and Oregon, Golden Eagles may be increasing as they make use of this expanded habitat.

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E. Cummins and D. Russell provided observations of a nesting territory on the Olympic Peninsula and Cascade Mountains, respectively. M. Cooper, M. Fuller, R. Knight, and others reviewed various drafts of the manuscript.

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## MATING BEHAVIOR IN THE GOLDEN EAGLE IN NON-FERTILIZATION CONTEXTS

by

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Gordon (1935) observed a pair of British Golden Eagles (*Aquila chrysaetos*) copulate late in the incubation period, hence long after it was necessary to fertilize eggs. Herein we report several observations of late season copulations at Golden Eagle eyries in North America, 2 observations of copulatory bouts in unusual behavioral contexts, and comments from the literature showing that this phenomenon is widespread if not well known for other birds of prey.

In species other than Golden Eagles copulatory bouts have been observed very early and very late in the breeding season. In the Ferruginous Hawk (*Buteo regalis*) Olendorff (1973) observed copulation while a pair was still on migration (spring) and Angell (1969) saw copulation in birds on territory but prior to nest repair. Mader (1979) reported copulation in the Harris' Hawk (*Parabuteo unicinctus*) with 5 week old young and Hamerstrom (1969) saw Northern Harrier (*Circus cyaneus*) copulation when their young were well fledged.

Copulatory bouts have been observed in unusual behavioral contexts. Retting (1977) reported a male Harpy Eagle (*Harpia harpyja*) attempting to copulate with the female when an observer moved down a tree limb toward the birds. Watson (1957) observed Snowy Owl (*Nyctea scandiaca*) displacement coition over 100 times during a single breeding season. Tulloch (1968) and Taylor (1973) also frequently observed displacement coition in the Snowy Owl following episodes wherein males escorted an intruder off the territories. Powers (unpub. data) observed Ferruginous Hawks perform copulation as a displacement activity in conflict situations: once when a Red-tailed Hawk (*Buteo jamaicensis*) was perched in the same tree with the pair, once when three coyotes (*Canis latrans*) were foraging nearby, once following a territorial interaction with two Swainson's Hawks (*Buteo swainsoni*), and once after the male was flushed by a human.

Observations herein were from 44 dawn-to-dusk watches at a Golden Eagle eyrie in the Sun River Valley, Montana, 1972. The bout reported below for Montana was made through observatin glass windows in a plywood blind less than 15 m away.

Of 21 copulatory bouts (Fig. 1) nearly all occurred before or after egg laying time when copulation was necessary for fertilization. Thirteen were observed or inferred (from vocalizations of hidden birds) after egg laying. Six followed hatching. The latest observed bout occurred 55 days after laying the last egg. When plotted chronologically the data suggest a bimodal distribution of timing of copulation bouts with peaks occurring at laying and hatching times. Interpretation is somewhat complicated, however, by an increase in observation days around hatching, and by the increased likelihood that an observer near the eyrie would miss a

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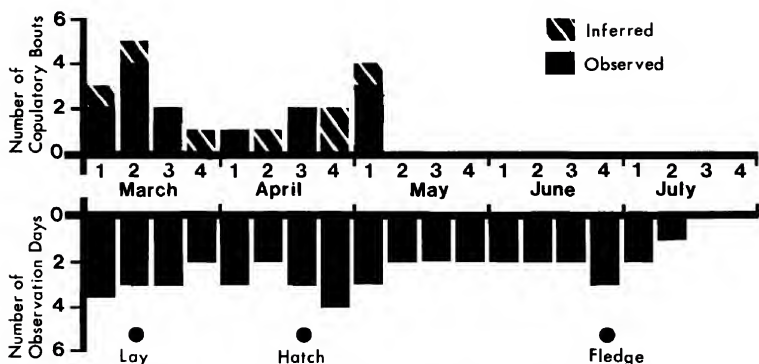


Figure 1. Chronology of copulatory bouts at a Golden Eagle eyrie in central Montana.

copulatory bout late in the season when the parent eagles were less closely tied to the nest.

Most of the late season copulation bouts were contextually similar to those occurring earlier; however, two were unusual. At 1135 on 5 May 1972 at the Montana eyrie a very large adult Golden Eagle (probably female) soared up ca 150 m west of the nest in company with the resident male. At 1140 the resident female, which had been on the nest from first light brooding 12 and 15 day old young, flew to the cliff rim above the eyrie and at 1142 protest called a long series of Shonk-Wonk notes (see Ellis 1979 for a description of calls). The female assumed the horizontal (copulatory) posture and, as the male swooped to approach her, she began calling the typical copulatory Pssa. The male lit on the female's back and perched ca 10 sec (an inordinately long time) before even starting to work his tail beneath the female's. Finally, the female broke her copulatory posture, snapped her head up and bit at the male's head as he sprang to a rock ca 1.3 m distant. After about 20 seconds the male flew to a perch ca 70 m east. The female departed from the cliff rim ca 10 sec after the male's departure.

The second unusual copulatory bout occurred 16 April 1980 at the Arizona eyrie when the eaglets were about 18 days old. In the evening of 15 April we constructed a blind ca 15 m from the eyrie. An adult was observed on the cliff after our departure at dusk, but no adult was on the nest early the next morning. At 0755 an adult (probably male) delivered food to the eyrie and appeared unalarmed by the nearby blind, but until we left at 1130 there were no additional entries. We resumed observations at 1400. Beginning at 1731 the adult female made a series of about 10 approaches toward the eyrie only to veer away before touching the rim. These approach bouts began with a segment several minutes in length wherein she soared to ca 200 m above the cliff. She then repeatedly stooped toward the eyrie and veered away, until she fell below eyrie level whereupon she flew to a slope with favorable winds and soared up again. Finally at 1807 the female touched down on the nest rim for ca 10 sec before fleeing. At 1811 the female lit on the rimrock ca 400 m from the eyrie. The male lit by the female and she lowered to a copulatory posture. The male mounted and remained for ca 9 sec. The male's side to side tail sweeping movements normally associated with copulation were readily seen as was the female's tail up posture, however, the female's copulatory vocalizations were not heard at the great distance involved. After the copulatory bout, the female performed about 25 additional stoop-veer bouts until she left the area in a long shallow flapping stoop. At 1853 the female lit on the nest rim ca 10 sec. At 1856 she lit and remained on the nest. At 1902 she began feeding eaglets. We discontinued observations shortly after 1920 while the female continued to feed the young into the dark.

In summary, birds of prey of several species have been observed copulating in contexts other than fertilization. At one Golden Eagle eyrie most of the copulatory bouts observed during a breeding season could not have served to fertilize eggs. Non-fertilization copulatory bouts likely serve some or all of the following purposes: territorial displays, a means of maintaining pair bonds or in timing reproductive readiness, and displacement activities in conflict situations.

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## GOLDEN EAGLE MOBBED WHILE PREYING ON COMMON RAVEN

by

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The Common Raven (*Corvus corax*) has seldom been recorded as a prey item of the Golden Eagle (*Aquila chrysaetos*) although the two species regularly occur together. Olendorff (1976) reported only two ravens in over 1,000 avian prey items for the Golden Eagle. This note reports an apparent predation attempt and subsequent mobbing episode involving the two species.

At ca 1000, on 17 June 1981, while driving in the mountains of central Arizona, I approached a group of 5 ravens mobbing a Golden Eagle in the roadway. The eagle, with wings outstretched, stood on a sixth raven. The ravens made repeated rushes at the eagle, thrusting and jabbing at its wings and body. Twice during this interaction, individual ravens jumped onto the back of the eagle and tugged on back and neck plumage for several seconds. Although no feathers were dislodged during these attacks, the eagle was visibly jostled and several times had to flap its wings to maintain balance. This mobbing continued for ca 5 min until the eagle, frightened by the approach of my vehicle, left the captured raven in the roadway and flew ca 150 m into a large arroyo where it perched low, out of sight in a grove of palo-verde trees (*Cercidium* sp.). The mobbing ravens, calling loudly, followed the eagle closely and perched in the upper branches of the same palo verde grove. Two ravens took off immediately after landing near the eagle and began soaring ca 10 m above while making repeated stoops on the eagle. The other ravens remained perched in the palo verde grove and continued to call frequently. No more actual attacks were made on the eagle and within 10 min, all 5 ravens were soaring above the eagle. The ravens then moved south until lost to view behind a low ridge. The eagle was absent when the grove was inspected ca 10 min later. The injured raven lay in the roadway ca 3 min but escaped my initial approach by crawling into a nearby bush. It was identified as a recently fledged juvenile. Later, the bird flew awkwardly across the mountain slope and was lost.

During the observation period, the ravens effectively prevented the eagle from plucking or killing the captured raven. While this observation was perhaps unusual, it suggests that mobbing behavior by the Common Raven can prevent predation on ravens by Golden Eagles.

This observation was made incidental to a study sponsored by the U.S. Fish and Wildlife Service. For helpful comments and suggestions, I wish to thank David H. and Cathy Ellis.

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## ABSTRACTS OF THESES AND DISSERTATIONS

## ECOLOGICAL ENERGETICS AND FORAGING BEHAVIOR OF WINTERING BALD EAGLES

The ecological energetics and foraging ecology of wintering Bald Eagles (*Haliaeetus leucocephalus*) were studied for 2 years on the Nooksack River in northwestern Washington and in the laboratory at Utah State University. During 36 food consumption trials, daily consumption by 4 winter-acclimatized eagles was 92.0 g/kg on a chum salmon (*Oncorhynchus keta*) diet, 74.8 g/kg on a black-tailed jackrabbit (*Lepus californicus*) diet, and 65.1 g/kg on a mallard duck (*Anas platyrhynchos*) diet which was inversely related to the wet energy contents (0.90, 1.22, and 1.96 kcal/g) of the diets, respectively. Daily consumption for combined diets was 88.4 g/kg at -10 C, 75.5 g/kg at 5 C, and 68.0 g/kg at 20 C. Daily gross energy intake, existence metabolism, and excretory energy for combined diets were 116.9, 94.3, 22.5 kcal/kg at -10 C, 101.8, 81.8, and 20.0 kcal/kg at 5 C, and 89.7, 69.1, and 20.6 kcal/kg at 20 C, respectively. Basal metabolic rate, as determined by oxygen consumption, was 2.771 kcal/g/hr with a lower critical temperature at 10.6 C and a thermal conductance of 0.083 cal/g/hr - C. Artificially-produced rain in the laboratory caused 9 and 21 percent increases in energy metabolism at rainfall levels of 6.1 and 22.2 cm/hr, respectively; however, natural rain levels in the Pacific Northwest were estimated to induce a negligible increase in metabolism. Deep body temperatures of 2 free-living eagles, measured with ingested transmitters, were highest during flight, intermediate during diurnal perching, and lowest during nocturnal roosting. This nocturnal depression allowed a 5 percent energy savings of total metabolic heat production. Ambient temperature, wind velocity, long-wave radiation, and rainfall data from 3 meteorological stations were used as input to the equivalent black-body temperature model to determine heat production of free-living eagles. Daily metabolic heat production varied between 383 and 426 kcal for a 4.5 kg eagle depending on habitat selection and time of day. By roosting in coniferous habitat rather than deciduous habitat, eagles experienced a 6% reduction in total heat production. Energy savings were attributed to milder wind speed, ambient temperature, and long-wave radiation conditions found in coniferous roosts. Flight activity, as monitored for 4 radio-tagged eagles for 38 days, involved only 1 percent of the 24-hour day and comprised only 6% of the daily energy budget. The daily energy budget (total energy metabolized) for a wild 4.5 kg Nooksack eagle was 407 kcal/day and daily energy consumption (total energy requirement) was 494 kcal/day; these values were approximately 10% greater than existence metabolism and gross energy intake of captive eagles, respectively. Daily consumption of 500, 364, or 296 g of chum salmon, black-tailed jackrabbits, or mallard ducks, respectively, is needed by a wild eagle to meet daily energy requirements. Intraspecific interactions while eating salmon on the Nooksack River were unusually high with kleptoparasitism being the primary means by which eagles procured food. Adult eagles were dominant over younger birds and were more successful at stealing food. Juveniles and subadults had low feeding efficiencies and consumed 410 and 459 g/bird/day of salmon, respectively, on an artificial feeding station which was less than the 552 g/bird/day ingested by adults. Young eagles thus failed to procure the needed 500 g/bird/day. The effects of this socially-mediated food deprivation on young eagles ranged from suboptimization of the time budget to possible starvation. Analyses of the



factors affecting winter energy budgets indicate that Bald Eagles exhibit physiological and behavioral traits which maximize energy-exploitation efficiency and minimize need-less energy drains. Protective management efforts should be directed at reducing energy stress thereby increasing overwinter survival.

Stalmaster, Mark Victor. 1981. Ecological energetics and foraging behavior of wintering Bald Eagles. Ph.D. Dissertation. Utah State University, Logan. 157 pp.

### BOOK REVIEWS

Haller, H. 1982. Raumorganisation und Dynamik einer Population des Steinadler *Aquila chrysaetos* in den Zentralalpen. Ornithologische Beobachter, 79:163-211. German with English summary and captions for tables and maps.

Important long-term study of a population of Golden Eagles that is believed at saturation level, now that human persecution has stopped. Concludes that rate of production is controlled by pressure from fledged immatures and non-breeding adults. Productivity is between .4 to .6 fledged eaglets per pair annually, whereas it can be twice that in a sparser, recovering population.

Dean Amadon

### ANNOUNCEMENTS: 1982 ANNUAL RRF MEETING

#### THANK YOU TO LOCAL COMMITTEE AND ALL PARTICIPANTS

We thank the following people, from the local committee, for all their time and energy donated in planning and coordinating the 1982 annual RRF meeting in Salt Lake City, Utah: James Gessaman, Albert Heggen, Owen Hogle, Ronald Joseph, Carl Marti, J. R. Murphy, Kathy Smith, James Ure, Stellanie Ure, Phillip Wagner, and C. M. White.

We thank all those students from Utah State University and Brigham Young University who helped in so many ways. We are also grateful to those who chaired sessions, and most importantly, we are thankful to those who shared their data with us through the papers they presented.

All of these working together made for a successful annual meeting.

**ANDERSON MEMORIAL AWARD**

The first annual William C. Anderson Memorial Award was presented for the best student's paper at the Raptor Research Foundation's annual meeting in November.

The winner was Jimmie R. Parrish, Dept. of Biology, Ecology and Systematics Section, Univ. of Alabama, University, AL, for his paper entitled "Identification of Peregrine Falcon natal locales by trace element analysis of feathers".

Three papers were noted as runners-up:

Diane Rains Epstein (co-author Gary E. Duke), Dept. of Veterinary Biology, Univ. of Minnesota, St. Paul, who presented the paper "A circadian rhythm of pellet egestion in Red-tailed Hawks";

R. Given Harper (co-author Thomas C. Dunstan), Dept. of Biological Sciences, Western Illinois Univ., Macomb, IL, who gave the paper "Foraging efficiency of adult vs. immature Bald Eagles at Lock and Dam 24, Mississippi River"; and

George Menkens (co-author Stanley H. Anderson), Wyoming Coop. Fish & Wildlife Research Unit, Univ. of Wyoming, Laramie, WY, who presented the paper "Characterization of Golden Eagle nesting habitat in northeast Wyoming".

Students gave 13 of the 43 papers presented.

**LESLIE BROWN TRUST FUND CONTRIBUTORS**

A separate saving account was opened last year to receive memorials for Leslie Brown. The opening balance was \$68.10. During 1982 the fund grew to \$876.89 thanks to contributions from Dean Amadon, Sally Spofford, Walter Spofford, Alan Harmata and a \$520 contribution from the Pan African Ornithological Congress.

**KESTREL SYMPOSIUM**

A one-day symposium on kestrel species entitled THE ANCESTRAL KESTREL will be held in conjunction with the annual Raptor Research Foundation conference on November 17, 1983 in St. Louis, Missouri. For further details, write:

David M. Bird  
Raptor Research Centre  
MacDonald Campus of McGill University  
21,111 Lakeshore Rd.  
Ste. Anne de Bellevue  
Quebec H9X 1C0 CANADA  
(1-514-457-2000, ext. 345)

**CONTRIBUTING AND SUSTAINING MEMBERS**

The Contributing members in 1982 were:

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Jack Cupper

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The Sustaining members (who contributed \$100 or more) in 1982 were:

Sally Spofford

Walter Spofford

UPI Library

Richard Thorsell

The Golden Eagle issue was organized by Richard L. Knight and he saw the manuscripts through to their final acceptance. We thank him and his reviewers David Ellis, Mark Fuller, and Joseph Murphy for their efforts.

—Editor

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